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HIS SURE DEFENSE

Coal and Ash Handling at Lake Shore Plant

By A. D. Williams

SYNOPSIS—In the Mar. 18 and Apr. 15 issues, respectively, were described the general features and the condensing system at this new plant of the Cleveland Electric Illuminating Co. The present article, dealing with the coal- and ash-handling system, brings out some new departures in this line and also shows that great care has been taken to prevent any interference in the plant operation from this source.

The coal-handling plant installed at the Lake Shore generating plant, at Cleveland, presents a departure from previous practice in similar locations. No provision has been made for running railroad cars containing coal directly over the bunkers and a very large storage capacity has been provided at the top of the bluff. The capacity of the bunkers over the boilers, however, has been made sufficient to cover any temporary breakdown in the conveying system. This arrangement results in a considerable reduction in the weight of the boiler-room steelwork.

All coal is delivered in cars and the plant is so arranged that train-load shipments can be cared for readily. Several thousand feet of track room are provided and these tracks are so laid out and connected that a number of cars may be unloaded at one time. A 3150-cu.ft. track hopper with grizzly and a 150-ton track scales are arranged so that coal may be delivered direct from cars to the conveyors feeding the boiler-room bunkers. An unloading trough 540 ft. long runs parallel with the reserve coal-storage pile under the gantry crane, which gives room to dump 15 hopper-bottom cars at one time. A shifting locomotive owned by the company renders it independent of those vexatious delays in handling cars in the yard which result from dependence upon the railroad for such service.

Storage capacity in the yard is provided for over 23,000 tons of coal, enough to run the plant a little over one month, the bunkers over the boilers will hold approximately five days' supply, and in an emergency sufficient coal could be stored to operate the plant several months. The storage yard is covered by a Brown Hoist gantry crane (see Fig. 1) having a span of 180 ft., and a 37-ft. cantilever extension covers two tracks, in addition to the one over the unloading trough. This machine is equipped with a 2-ton clam-shell bucket. Normally, coal is lifted from the unloading trough to the stock pile or from the stock pile to hopper-bottom cars, which are shifted to the scale and track hopper for supplying the boilers. In this work the crane is not shifted very frequently on its runway; hence the bridge travel of 200 ft. per min. is operated by the 112-hp. hoisting motor. The bucket-hoisting speed is 200 ft. per min. and the trolley speed 1000 ft. per min., the latter operated by a 52-hp. motor. These motors run on 230-volt, three-phase, 60-cycle current and are controlled from the operator's cabin.

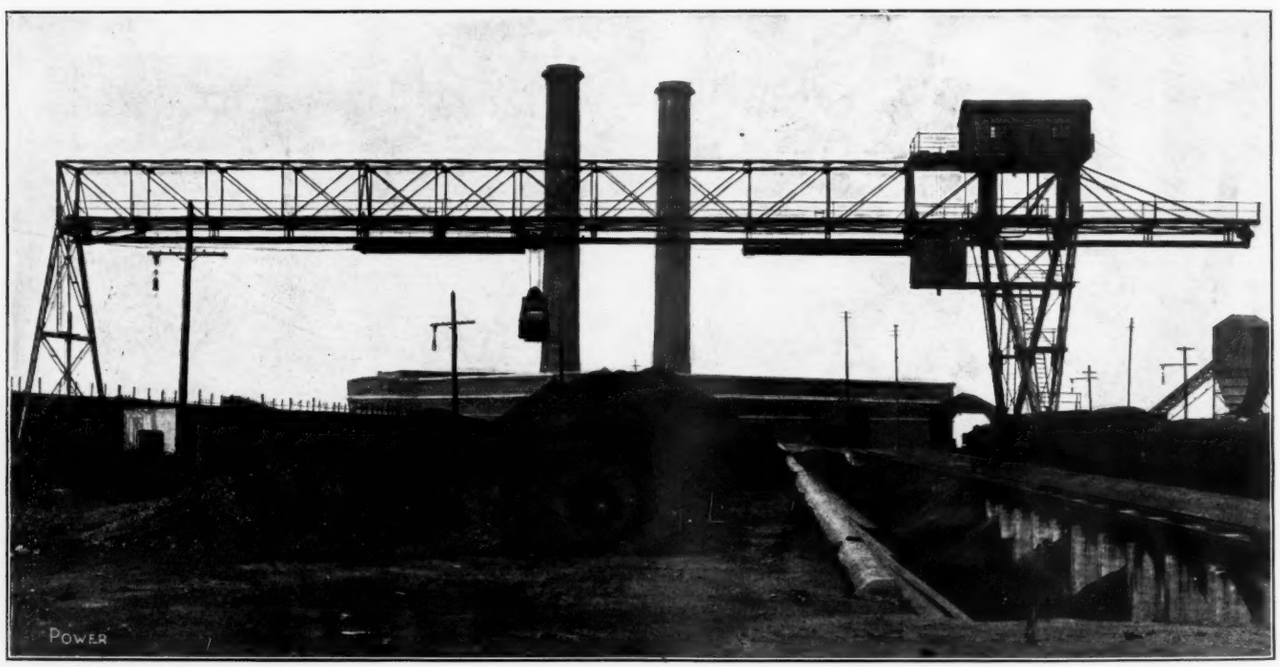


Fig. 1. Gantry Crane over Storage Yard

The 150-ton track scale, Fig. 2, over the receiving hopper is so located that all coal coming into the plant, either for storage or immediate consumption, can be weighed. If intended for the bunkers, the coal is dumped into the track hopper from which it passes through plunger feeders to Bartlett & Snow four-roll coal crushers, Fig. 3, and thence to the inclined conveyor belt, elevating it to the upper portion of the boiler room. The crushers and feeders are installed in duplicate, either one of the pair being of sufficient capacity to cover ordinary demands. A bypass for fine coal is provided so that the crushers will not become choked. This limits their service to the crushing of the larger lumps. The track hopper and crushers are installed in a pit at the top of the bluff.

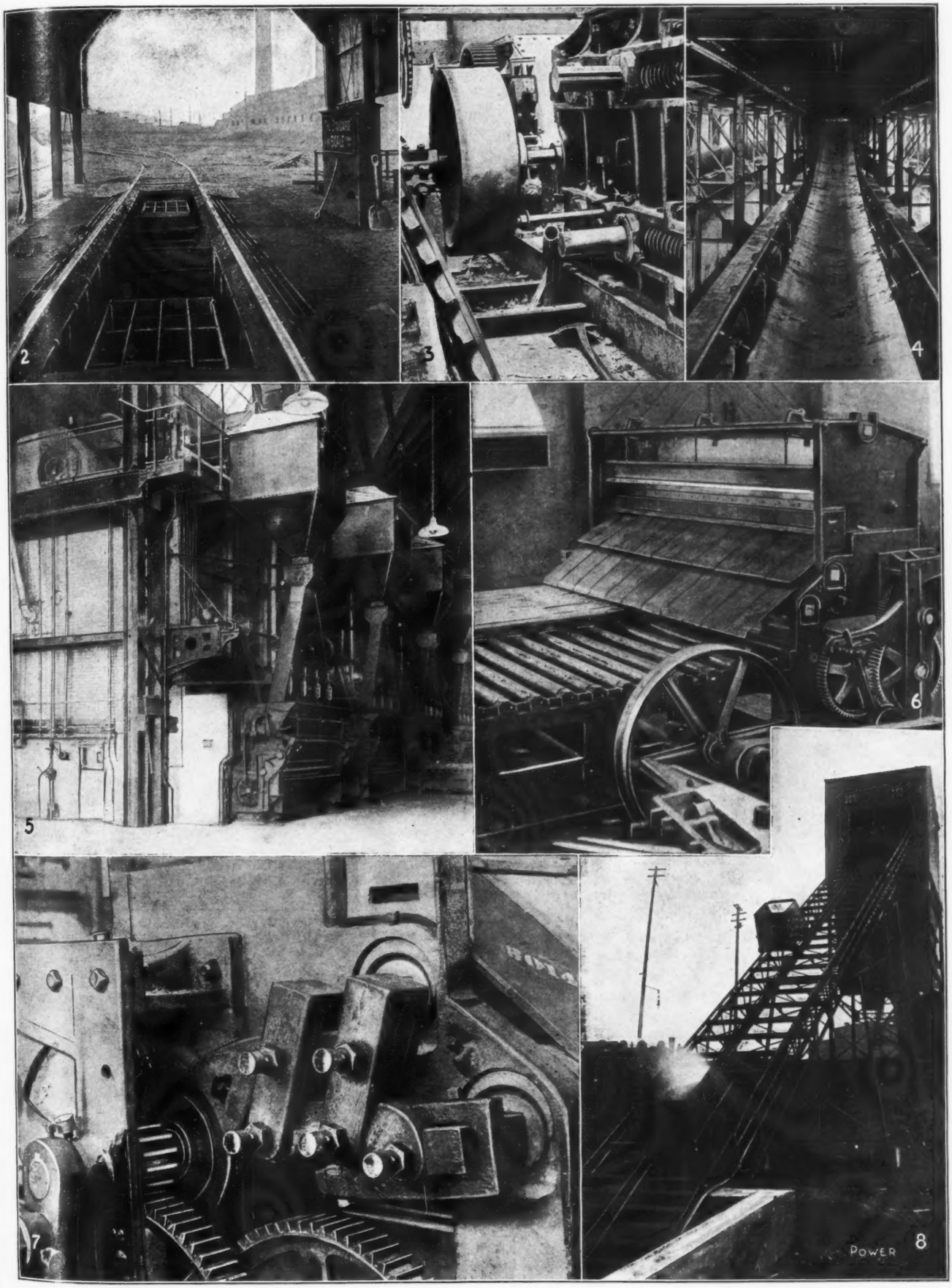


FIG. 2. TRUCK SCALES. FIG. 3. FOUR-ROLL CRUSHERS FIG. 4. BELT CONVEYOR. FIG. 5. WEIGHING HOPPERS IN FRONT OF BOILERS. FIG. 6. CHAIN-GRATE STOKER. FIG. 7. AGITATING MECHANISM OF STOKER. FIG. 8. SKIP AND ASH-STORAGE BIN.

A 30-in. conveyor belt with an inclination of 13 deg. raises the coal from below the crushers to a conveyor gallery on the south side of the boiler room and discharges either to the No. 1 bunker conveyor or to a distributing conveyor, which carries the coal to any one of the other bunker conveyors. The bunker conveyors and the distributing conveyor at right angles with them are 30-in. belts; one of these is shown in Fig. 4. The tripper on the latter is hand propelled as it is shifted from bunker to bunker only as it becomes necessary to supply coal to them. The trippers on the bunker conveyors are of the traveling type with reversing stops which can be set to limit the travel of the tripper to that portion of the bunker in which it is desired to distribute the coal.

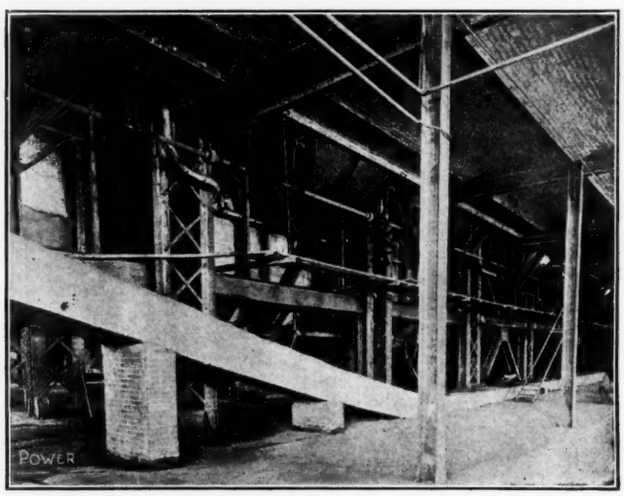


FIG. 9. ASH HOPPERS

The power consumed by these conveyors is given by their builders as follows:

	Horsepower at Motors		Load in Tons per hour
	Light	Loaded	
Inclined conveyor, 13-degree slope, 302 ft.	...	23.5	162
	...	36.0	277
Distributing conveyor, 250 ft. long	6.8	12.2	242
Bunker conveyor, 200 ft. long	6.2	9.8	217

The concrete-lined bunkers above the boiler-firing aisles, provided for holding a few days' supply, have hopper bottoms and gates over each boiler. The west bunker, No. 1, serving a single row of boilers, has a capacity of 1000 tons, and the other bunkers 2000 tons each, the latter serving to supply two rows of boilers. This gives an immediate supply over each boiler of about 100 tons. From the bunker the coal flows by gravity into a weighing hopper, Fig. 5, holding 5 tons, from the bottom of which the coal flows into the spreader chute leading to the stoker.

The Green chain-grate stokers in this plant have been especially designed for use with caking or semi-caking coals. They differ from the usual construction in having an inclined agitating foreplate, Fig. 6, upon which the coal flows from the stoker hopper. This foreplate consists of two leaves, the lower edge of the upper lapping the lower and the lower edge of the bottom leaf resting upon the chain grate. These two leaves have a reciprocating motion, the upper moving forward as the lower is drawn back; the agitating mechanism is shown in Fig. 7. The igniting arch is immediately over the foreplate and the continual agitation of the fuel bed at this point prevents caking and hastens the driving off of volatile combustibles, which are drawn forward over the incandescent bed of coal. These stokers have a grate area of about 110 sq.ft. each, and their rate of grate travel can be adjusted to suit the demand, up to a maximum travel of 10 in. per min. The rate of combustion ranges from a normal value of 20 lb. of coal per square foot per hour to 40 lb. This latter rate, however, has been exceeded when forcing the boilers, the maximum under these conditions approximating 65 lb.

There are two hoppers below each boiler. The rear one, for the ashes, of ferroinclave and concrete, below the rear 6 ft. of the grate, has a double-hopper bottom and gates for discharging the ashes into an electric larry. A plate-steel hopper, Fig. 9, below the front 5 ft. of the stoker has a spout and gate that discharges between the two gates of the ash hopper. This steel hopper is designed to recover the partially burnt coal that falls through the grate.

The larry for the ashes runs on tracks laid on the basement floor below each row of boilers and connecting with two cross tracks close to the south side of the plant, running over a hopper from which the ashes can be discharged into a skip for raising them to an ash-storage bin located at the top of the bluff; see Fig. 8. This ash bin, which is of the parabolic suspension type, is about 200 ft. south of the plant and its top is 50 ft. above the tracks at the top of the bluff, making the total lift of the

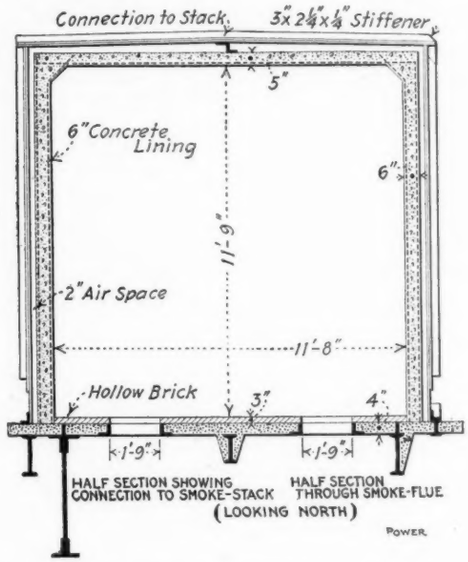


FIG. 10. SECTION THROUGH FLUE

skips about 135 ft. Each of the skips is of 200 cu.ft. capacity, and the skip hoist is of the automatic counterbalanced type, the cars dumping at the top of their run. Electrically operated discharge gates are provided for loading cars; these grates are fitted with steam-thawing nozzles and coils for use in cold weather.

The boilers are of the Stirling type with a Foster superheater having 800 sq.ft. of heating surface located in the second pass. The gases of combustion are drawn forward over the bed of coals on the stoker under a combustion arch and through special baffling designed by John Wolff, steam superintendent of the Cleveland Electric Illuminating Co. The boiler uptakes to the smoke flues are short and direct: 17.5 sq.ft. of area for each boiler. These

connect with the main smoke flue through asbestos-packed slip joints. The main smoke flue is of plate steel lined with reinforced concrete on the top and sides and paved with brick; see Fig. 10. Two flues connect with each chimney, each flue carrying the gases away from eight boilers and two boiler uptakes enter the bottom of the stack.

The chimneys are of steel plate lined with brick, the shaft being 216 ft. high and 18 ft. 6 in. diameter inside the lining; the height above the grates is 246 ft. Each chimney is designed to carry off the gases from 18 boilers. These chimneys are supported upon heavy girders carried by the building columns, which at this point are tower braced to carry the wind reactions to the foundations. The tops of these chimneys are about 270 ft. above lake level.

Two 14 and 10.5 by 18 Hughes duplex pumps supply makeup water to the boiler-feed line. This and the condensate from the turbines forms the boiler-water supply. This water passes through six-pass feed-water heaters having 1200 sq.ft. of heating surface for each unit. Each double row of boilers is supplied through three feed lines, one in the center with taps to both rows of boilers. A second feed line runs under the front end of the boilers in each row and serves only the single row. Each of these lines is metered by a venturi meter, which indicates the rate of flow, and also the total flow. Taps from these pipes enter the rear drums of the boilers the water in each case passing through a check valve and a gate valve on top of the boilers. This duplex-feeding system is designed to avoid any possibility of interrupting the service from a boiler through trouble with the feed lines; the layout is shown in Fig. 11.

The steam from the boilers passes through the superheaters, which are designed to superheat 15,250 lb. of steam per hour at 215 lb. pressure to 100 deg. F. In actual service much better results than this have been attained. The pitot orifice of a General Electric indicating steam meter is inserted in the superheater outlet just below the nonreturn stop valve and gate valve in the boiler connection to the steam line.

The blowoff outlets, two to each boiler, pass down through the floor to a blowoff header to which they make Y-connections. No blowoff tank is provided, the water being discharged directly into Lake Erie.

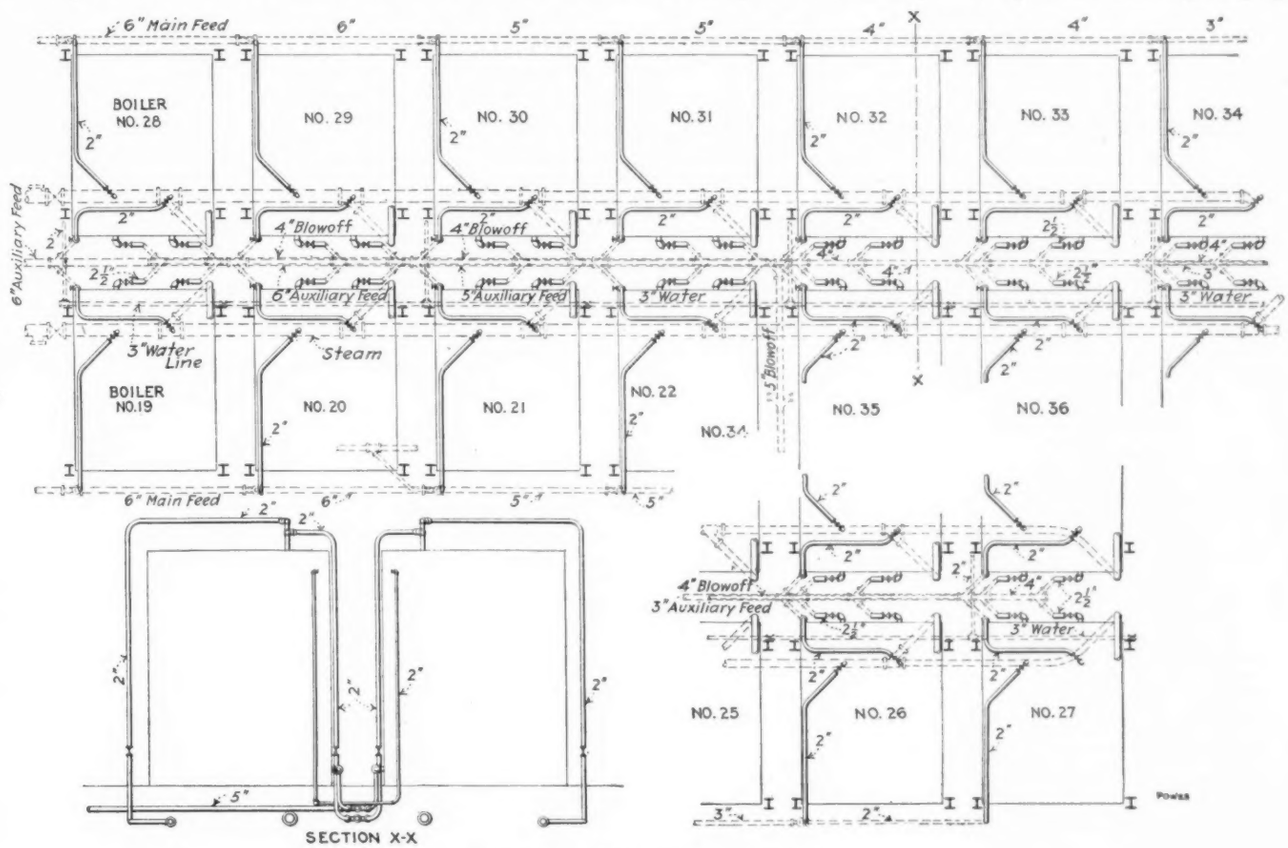


FIG. 11. BOILER-FEED SYSTEM

Cleveland Railway to Purchase Its Power

The purchase of street-railway power has been undertaken by the Cleveland (Ohio) Ry. Co., which is giving up the generation of its own electrical energy. It is under contract now to purchase 11,000-volt, three-phase, 60-cycle power from the Cleveland Electric Illuminating Co. This will be supplied to four substations equipped with rotary converters of special design, and storage batteries. The initial equipment of these stations will aggregate 15,500 kw. converter capacity with a possibility of increasing this to 25,000 kw.

Graphical and numerical records are to be kept by the substation employees, and forwarded to the railway company's power department each day for totalizing. As an aid to efficient operation the substation records will also show plotted the capacity of machines running at each hour, so that it will be evident what approach is obtained to full load on the equipment in service.

Training Engineers at Yale

By Thomas Wilson

SYNOPSIS—Methods of training and the equipment of the laboratory. A testing floor facilitates the exchange of machines, and an interesting feature is the provision for transporting the smaller machines and apparatus to the rostrum of the lecture room.

Within the last 25 years, the development in engineering has been rapid and far reaching. New fields, better methods and improved machines have followed each other so rapidly that it has become difficult to keep pace with the times. In training students to enter this field, a corresponding advance has been required, and to crowd in all the information and training required in the brief four years allotted to a course, has become a serious problem. In fact, it is impossible to give the student very much of the information necessary to an engineer of today. A thorough grounding in fundamentals and engineering methods of analysis rather than the acquirement of a large number of facts appears to be the aim of modern schools.

Nevertheless, some knowledge of modern manufacturing, new types of machinery and methods of conducting tests must be imparted. It has been the policy in colleges of engineering and technical schools to equip their laboratories with all the machinery that they could afford to buy or induce some manufacturer to give them. These machines, and the general equipment, were permanently installed, and used year after year by the students. If there was space for additional equipment and money for its purchase, new equipment was added. It is easy to see that much of the equipment must soon become antiquated, and the laboratory filled with out-of-date machinery. The wisdom of such a course depends somewhat on geographical location. Where the student has little or no opportunity to gain previous or simultaneous experience in the vacation period with engineering practice, and the laboratory is far removed from an industrial center, the old policy is perhaps the better way. Even if the machine is out of date, the experience gained in running or testing it may be of some advantage in a professional career.

In New England, the great industrial center of the country, where machines of all kinds and of the latest types are readily accessible for testing or inspection, there is not so much need for a laboratory filled with permanent equipment. Of the prominent instructors in mechanical engineering in this country, Prof. L. P. Breckenridge, of the Sheffield Scientific School of Yale, was the first to break away from the older plan, and arrange a laboratory which would always have equipment of the latest design. The opportunity came when he was called to Yale and had the privilege of laying out in 1911 the Mason Laboratory of Mechanical Engineering. One of its prominent features is the testing floor, on which machines of all descriptions can be readily mounted or removed. A few standard machines, such as a Corliss engine and a steam-turbine generating unit, used for lighting the building, have been permanently mounted, but the general policy is to arrange for a loan of various types of machines for one or two years. They are then returned to the maker and a later machine of the same, or perhaps another design, takes its place. With a testing floor served by a 10-ton crane, the exchange is easy, and the students get the benefit of a variety. In addition to the many types of engines, pumps, fans, small boilers, etc., automatic machines of the latest design, with their variety of products, are brought in for a period of two weeks, and are usually accompanied by an expert demonstrator from the factory where the machines are made. In the course of a year, there is opportunity to show several machines of different types, so that during his training the student becomes familiar with the latest and best in machinery.

A carefully planned three weeks' course each year in shop visiting supplements the work. The students get valuable ideas of manufacturing methods, and these visits together with the excellent manual training now given in high schools in the East and their work in vacations in the numerous shops in New England, serve the purpose nearly, if not quite, as well as an extended course in shop training. In these days of progress, most everything is specialized, and it would be impossible to give the student a thorough training in all branches. In most cases a working knowledge of the line he is to follow must be gained after the period of instruction.

In the laboratory, there is a fairly complete equipment of small, self-contained machines, such as pumps, gas engines, small high-speed steam engines, a suction gas-producer outfit, testing machines of the Riehle and Olsen types, varying in capacity from 50 to 200,000 lb., steam traps, condensers, a Pelton waterwheel, a Uehling combined pyrometer and CO_2 recorder, heating boilers, a ventilating fan, tempering coils, and the like. A full line of scientific instruments and facilities for testing have been provided, to test the machines and apparatus in the laboratory, those that may be sent in for the purpose, and for power-plant tests of all kinds carried on outside the laboratory.

A feature of special interest is the provision made for taking small machines from the testing floor to the lecture room. They are first picked up by the 10-ton traveling crane serving the main floor, and delivered on the gallery platform at the entrance to the lecture room on the second floor. From here a 2-ton hand crane on a trolley rail carries the machine or apparatus onto the rostrum, where it is placed on exhibition or taken apart, as desired. Instead of the sketch or lantern slide the actual machine is often at hand to illustrate a lecture. The advantages of such a plan will be realized. The lecture room itself is a model of convenience. Much attention has been given to ventilation and lighting.

The general arrangement and construction of the building was made plain in our issue of Feb. 7, 1911, so that a repetition will not here be necessary. The purpose of the present article was to outline the equipment and the methods of training, and while doing so, it will interest many to learn that besides training the undergraduate and giving excellent opportunities for post-graduate work, there are plans forming to conduct coöperative industrial research work, such as is carried on in many of the Ger-

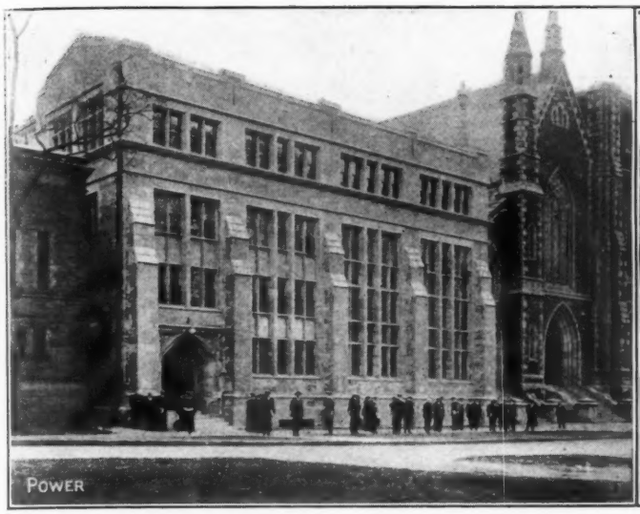


FIG. 1. MASON LABORATORY OF MECHANICAL ENGINEERING

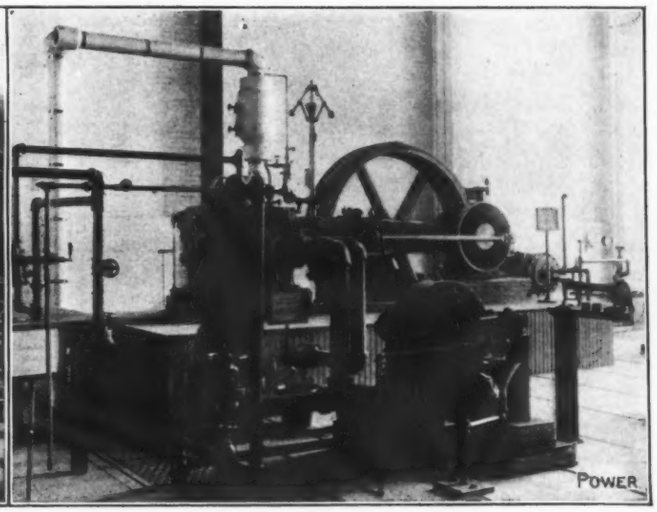


FIG. 2. AN OLD CORLISS AND A NEW TERRY TURBINE, BOTH RATED AT 40 HP.

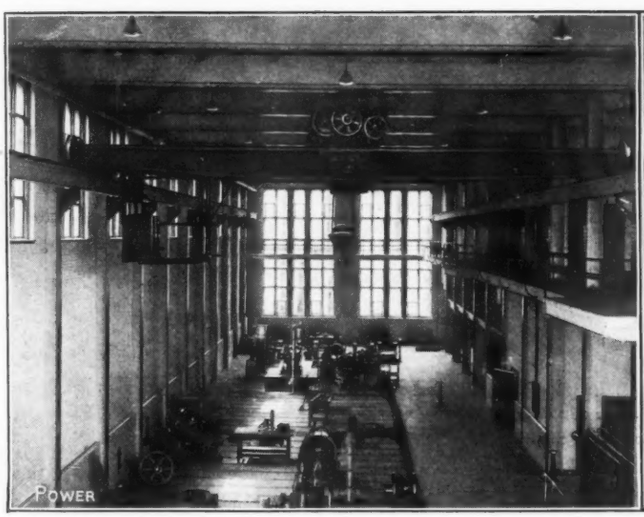


FIG. 3. PORTION OF TESTING FLOOR

FIG. 4. ONE OF THE RIEHLE TESTING MACHINES

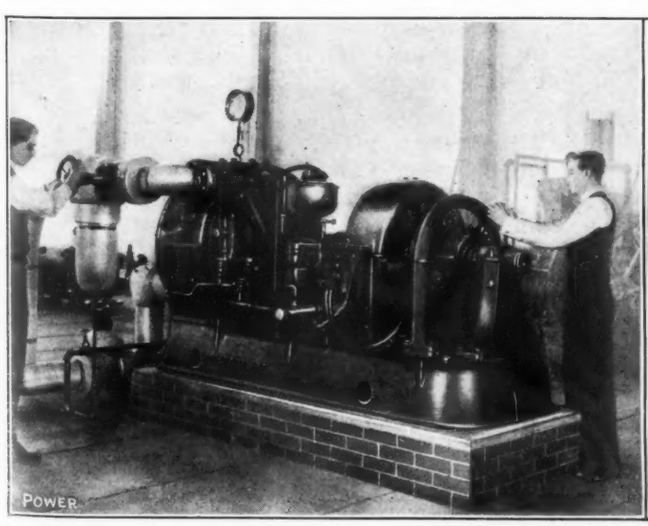


FIG. 5. CURTIS TURBO-GENERATOR SET

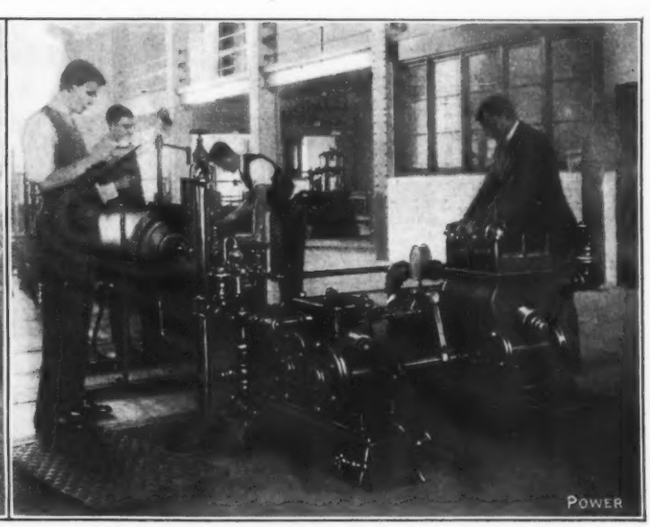


FIG. 6. DEANE STEAM PUMP

man technical schools as well as in the experiment stations of various state universities in this country. As the laboratory has only recently been completed, not much as yet has been accomplished in this line. At present, some work is being done on the domestic fuel problems of New England. A number of heating boilers, loaned by the makers, have been fitted up for testing the different kinds of fuel and economic methods of burning. Some testing work for the brass, copper and alloy interests is also on foot, and, in the course of time, it is expected that this phase of coöperative testing work will be of great assistance to engineering and industrial interests throughout New England.

The recent expansion of the engineering side of the work of the Sheffield Scientific School at Yale seems to promise some interesting and valuable developments. Science and engineering must more and more help each other. Yale is located in the midst of industries, and it would be only natural that science, engineering and industries should coöperate to the advantage of each.

A German Soot and Cinder Arrester

By Otto E. Trautmann

SYNOPSIS—A water spray and slag-cinder filter combination so effective that no black smoke, soot or cinders are emitted. White cloth held some time over the stack is only slightly discolored.

As methods of abatment of the smoke nuisance in cities are at present receiving attention it is of interest to note what means have been employed abroad. One of the most

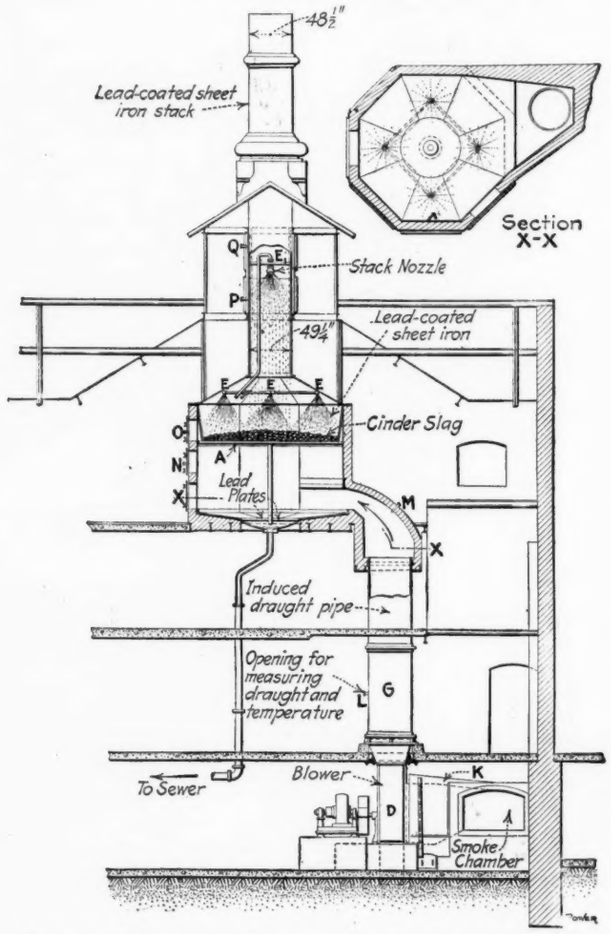


Fig. 1. Sectional Elevation. German Soot and Cinder Arrester

successful foreign installations for preventing the soot and cinder nuisance is in operation at the municipal power plant of Pforzheim, Badenia, Germany. Some time ago the increasing demand for electric current required enlarging this plant and erecting a new stack which, out of aesthetic consideration for the locality, was carried up only 70 ft. high. This made mechanical draft necessary for three new water-tube boilers, each of which has 2375 sq.ft. of heating surface and 65 sq.ft. of grate surface in chain grates. German bituminous coal is used and the plant has been in successful operation for about five years, the only trouble experienced consisting of a slight fall of condensed steam during times of heavy rainfall. When the boilers are first started the stack discharges a yellow cloud of steam, but the color soon changes to white as the operation of the plant is continued. Pieces of white cloth placed over the outlet of the stack and kept there for a considerable time during the ordinary running of the plant, show only a slightly grayish color without having gathered any particles of soot or cinder.

Fig. 2 is a plan showing the general arrangement of the boiler additions referred to and their draft connections, and Fig. 1 is a sectional elevation showing the induced-draft blowers, stack and cinder catcher. Referring to Fig. 2, B_1, B_2 and B_3, are the boilers with smoke connections C_1, C_2, C_3, which discharge into the main smoke chamber F.

The exhaust blower D receives the smoke from the boilers by a short breaching connected with the smoke chamber and forces it into the pipe G, Figs. 1 and 2, from which it passes into the main receiving chamber of the cinder catcher, Fig. 1, which has a cross-sectional area of about twelve times that of the stack. This receiving chamber is of brick, lined on the sides with interchangeable lead-coated sheet-iron plates, while the bottom is covered with lead-coated plates which slope to an opening in the center which is connected to the sewer. Near the top of the chamber is a lead-coated grating A for supporting a bed of broken cinder slag, and above the slag bed is a cluster of nozzles *EEE* for spraying water as the smoke filters through the bed of slag. A similar cluster of nozzles is provided a little higher up in the stack at E_1. The slag consists of boiler clinker gathered from the ashes made at the plant, the clinker being broken up to about the size of nut coal and spread over the grating, forming a filter bed 12 to 16 in. thick. The water pressure is made just sufficient to raise the water to the height of the spray nozzles with sufficient pressure at the nozzles to properly atomize the sprays.

When the gases from the boiler furnaces enter the receiving chamber, their velocity is reduced, owing to the enlargement of cross-sectional area, and they part with most of their contained solid matter. Then they filter

through the slag filter bed above and any remaining solid matter held in suspension is washed out and the gases are also largely deodorized. The stack and roof of the receiving chamber, and all iron work exposed to the corrosive action of the gases are either protected by a covering of sheet lead or constructed of lead-coated iron.

The above table is compiled from a report of tests of the installation made by M. Werner, superintendent of the station. The columns headed *K, L, M, N, O, P, Q, R, S* refer to draft, pressure and temperatures taken at points which bear the same letters of reference in the illustrations; draft and pressure are quoted in inches of water and temperatures in degrees Fahrenheit. The speed and power required for the blower, amount of spraying water used per hour and pounds of coal burned per hour are quoted in separate columns.

DATA OF TESTS OF A GERMAN SOOT AND CINDER ARRESTER

Boiler in Operation	Measurement Points K	L	M	N	O	P	Q	R	S	Blower R.p.m.	Blower Hp.	Spraying Water per Hour	Pounds of Coal Burned per Hour
B_1, B_2 Draft	$\frac{3}{8}$	...	...	...	$\frac{1}{16}$	$\frac{1}{16}$	$\frac{1}{16}$	$\frac{1}{16}$	...	210	15	Stack spray only 1000 gal.	3000
Pres.	...	...	...	1	...	...	...	...	...				
Temp.	460	435	415	390	372	122	125	...	...				
B_1, B_2 Draft	$\frac{3}{8}$	...	...	...	$\frac{1}{16}$	$\frac{1}{16}$	...	$\frac{1}{16}$	...	193	12	Stack spray only 1000 gal.	2800
Pres.	...	...	...	$\frac{3}{4}$	...	...	$\frac{1}{16}$	...	...				
Temp.	485	464	445	398	380	124	130	...	...				
B_2 Draft	1	...	...	...	$\frac{1}{16}$	$\frac{1}{16}$	...	$\frac{1}{16}$	...	217	19	Stack spray only 1000 gal.	3200
Pres.	...	...	...	$\frac{3}{4}$	...	...	$\frac{1}{16}$	...	...				
Temp.	473	446	425	360	350	122	126	...	...				
B_3 Draft	$\frac{3}{8}$	...	...	...	$\frac{1}{16}$	$\frac{1}{16}$	0	...	$\frac{1}{16}$	225	20	Stack spray only 1000 gal.	3500
Pres.	...	...	...	$\frac{11}{16}$	...	...	0	...	...				
Temp.	435	428	392	290	330	120	126	...	...				
B_3 Draft	$\frac{11}{16}$	...	...	...	$\frac{3}{16}$	$\frac{1}{16}$	$\frac{1}{16}$	...	$\frac{1}{8}$	177	9	Stack spray only 1000 gal.	1760
Pres.	...	...	...	...	$\frac{1}{16}$	...	...	...	...				
Temp.	385	376	349	292	261	110	116	...	...				
B_2, B_3 Draft	$\frac{3}{8}$	...	...	...	...	0	0	...	$\frac{1}{16}$	203	15	Stack and Filter sprays 1800 gal.	2930
Pres.	...	$\frac{1}{8}$	...	$\frac{1}{8}$	$\frac{1}{16}$	0	0	...	...				
Temp.	500	470	454	338	311	125	138	...	...				

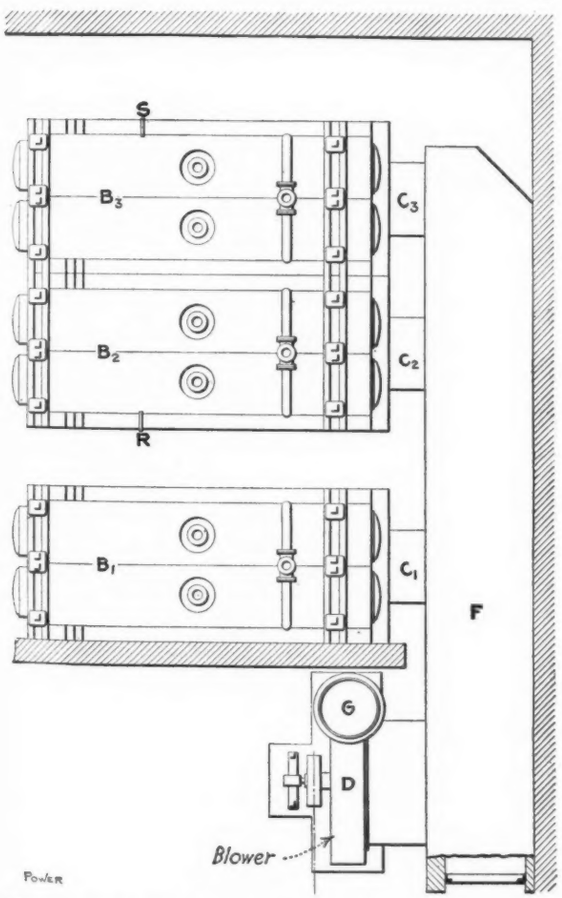


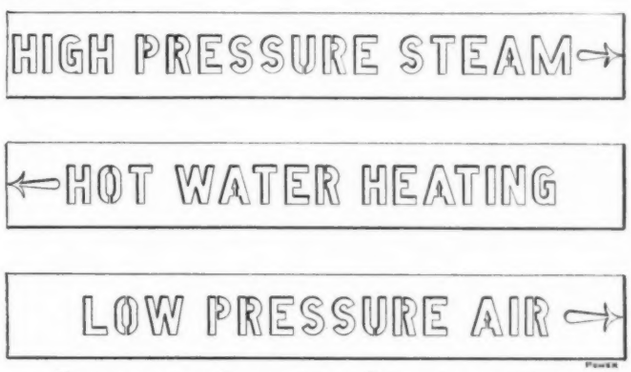
FIG. 2. PLAN OF BOILERS. GERMAN SOOT AND CINDER ARRESTER

Identifying Pipes

BY L. B. LENT

The writer does not remember seeing in POWER any mention of the admirable practice of stenciling the various lines of piping about a power plant or factory instead of painting them distinctive colors.

Much has been said about painting them and many colors suggested. To me, the principal objection to this system is that one must carry around a color guide or chart in order to identify pipe lines unless one's memory is better than mine. A simpler and better way is to letter each pipe at frequent intervals and also mark the direction of flow alongside the letters. This can be readily done by using stencils. Such marking may be illustrated as follows:



FACSIMILE OF STENCIL FOR IDENTIFYING PIPES

The direction of the arrow shows the direction of flow in each pipe, and such knowledge is often as important as knowing the contents of the pipe. The markings may be 25, 50 or 100 ft. apart, according to the demand of circumstances.

Boiler Blow-Down Recorder

BY PAUL A. BANCEL

The writer recently visited the Phoenixville, Penn., shop of the Heine Safety Boiler Co., and had a conversation regarding blowing down of boilers. Some interesting points which may be of interest to your readers were observed.

The accompanying chart, Fig. 1, is from a Crosby boiler-pressure recorder located in the engine room of the plant, showing about 105 lb. average steam pressure during the working period of the day.

Near the outer circumference of this chart is a series

of dots, one for every hour. These dots show just when the mud drum of a boiler was blown down. Blowing off the mud drum frequently for short periods, instead of periodic blowing for long periods, is less wasteful of heat and prevents sludge and other impurities from clogging

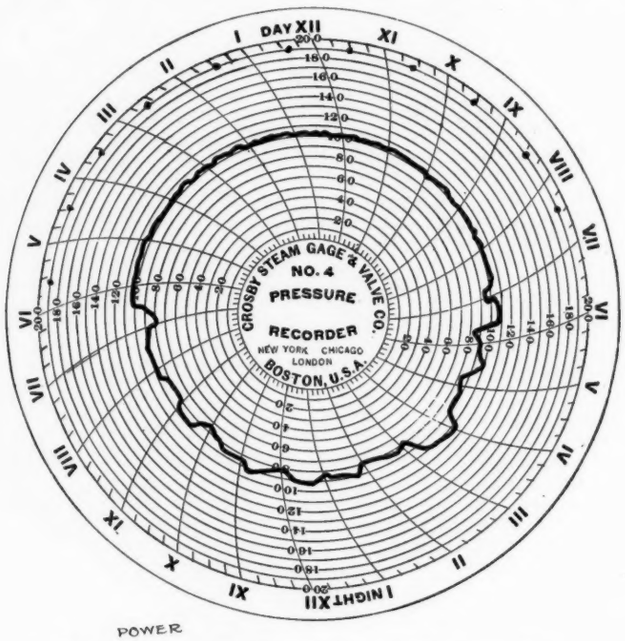


FIG. 1. DOTS SHOW WHEN THE BOILER WAS BLOWN DOWN

up the mud drum and then entering the boiler tubes. Although these impurities are mostly what is called soft scale, if they enter the boiler and combine with the scale deposited in the process of evaporation, they will form a hard scale.

While frequent cleaning of the mud drum is desirable, the tendency in the boiler room is to let the matter go and not blow down regularly. An automatic device for recording the time when a boiler is blown off thus gives the engineer a check on the fireman and insures regular blowing down of the boilers. The home-made apparatus for giving this record, as used in the Phoenixville plant, is shown by Fig. 2.

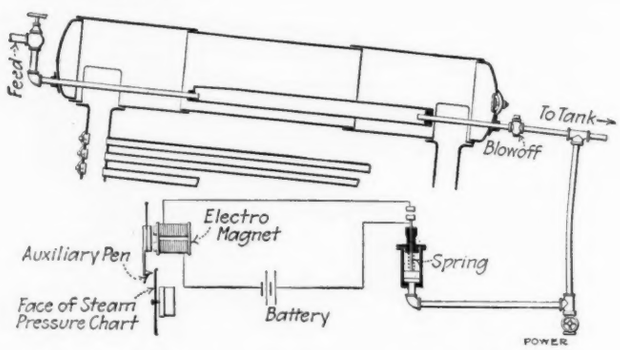


FIG. 2. CONNECTIONS OF BOILER BLOW-DOWN RECORDER

Between the blowoff connection and the tank into which it discharges, there is connected a small pipe leading into the engine room where it is connected to a device which closes an electrical contact whenever the blowoff valve is open. This consists of a cylinder in which fits a piston working against a spring. When the blowoff valve is open, the pressure acts against this piston, overcomes the resistance of the spring and closes two electrical contacts.

This causes the current to flow through an electromagnet, situated just above the steam gage on the engine-room gage board. The electromagnet in turn causes an auxiliary pen to press against the steam chart, thus making the dots at the exact time when the blowoff was opened. This device was worked out by engineer James D. Darrach.

Vertical Terry Turbines Developed and Standardized

A complete line of Terry vertical turbines of from 5 to 600 hp. at speeds of 3600 to 500 r.p.m. has been developed and standardized.

These machines can be dismantled without disturbing the steam connections, and except for the smaller sizes, where all the parts are so light that they can be easily lifted, the casing is divided on the vertical axial plane and the cover or half casing is hinged.

All bearings are supplied with forced lubrication from an oil pump on the main shaft. The thrust is taken by a ball bearing, the balls of which are in oil when starting. A constant circulation of oil through the bearing while running keeps the balls and races cool, clean and free from grit.

These turbines are compact, of light weight and are of the single-stage type, with shaft extension to receive a fan or connect with a centrifugal-pump shafting. These turbines are manufactured by the Terry Steam Turbine Co., Hartford, Conn.

The company has recently put on the market a new type of turbo-alternator, known as the "Terry type C. H. S.," to operate at 3600 r.p.m.

Toledo Pipe Cutter

This tool has been designed to cut off pipe in sizes ranging from 2½ in. to 6 in. The cutting is done by four knives, which are automatically fed by star feed. Two of these knives are beveled across the edge, and cut a V-shape section in the pipe. The other two knives are square, and follow in the V-shape cut.

The tool is fastened to the pipe by a three-jawed chuck, each jaw being actuated independently, and containing a set of size marks so the tool can be centered on the pipe quickly. The knives are sent down to the surface of the pipe by turning the "stars" by hand, until each knife in succession comes in contact with the pipe. The tool is driven by a pinion working on a bevel gear, the pinion being operated with a ratchet handle.

The knives are straight pieces of steel, and can be readily reground.

The tool is made in two sections, and splits in two after removing four capscrews. This permits of placing it upon any pipe line before a joint is broken. After placing on a pipe, the two sections are bolted together, and made rigid by dowel pins.

This tool is manufactured by the Toledo Pipe Threading Machine Co., Toledo, Ohio.

Ideal Armored Pump Valve

The material from which this valve is made is a vegetable product treated by a process that is intended to render it nonsusceptible to the effect of steam, oil, ammonia, gasoline, turpentine, etc. It is subjected to pressure, making the material into a solid and practically inseparable form. The seating surface of the valve disk is from one solid piece of this material.

The valve, as a whole, is made of three pieces, an outer casing of copper or brass, secured to the inner casing and valve disk by four screws. The smaller, or inner, casing fits in a recess in the valve proper and does not come in contact with the valve seat.

Should the inner valve face around the valve stud, or the outer face become worn, they may be refaced and made as good as new. The same valve answers for hot- or cold-water service and about the only thing it will not withstand is strong acids. This valve is made by the Lake Erie Boiler Compound Co., 192-198 Chicago St., Buffalo, N. Y.

Conditions when Estimating the Cost of Power Plants*

By Frederick W. Gay†

Those who make estimates realize the great number and variety of conditions which influence their selection of costs for an estimate on any two separate but similar contracts; in other words, the influence of "local conditions." It is not intended to refer to any particular estimate or specific case, but to analyze the various items which make up the whole in the case of steam-power plants and pumping plants only.

A great many engineers are called on to submit estimates before accurate or sufficient information is at hand as to details of any but the larger and principal pieces of apparatus. Personally, the writer has to make estimates even before any drawings or specifications are available, or even before the preliminary surveys of the site have been made. Many of these estimates cover the expenditure of a great deal of money, and naturally the responsibility is in proportion to the amount of money that is involved.

In some cases estimates can, of course, be checked against cost analyses of similar work already done. Local conditions in new work require that figures from such cost analyses be modified to suit these conditions. How can one check his figures and have any assurance of their accuracy?

Diagrams compiled from data which cover plants from 2000 to 40,000 kw. capacity show that: Engines and foundations constitute from 33.6 to 61 per cent. of the total equipment cost; an average of 50 per cent. Boilers, settings and foundations, from 17.25 to 31.5 per cent., average about 25 per cent. Piping, complete, from 7 to 17 per cent., average about 11 per cent. Condensers complete with foundations and auxiliaries, 10 to 15 per cent., and average 11 per cent. Circulating-water system, 4.5 to 8 per cent., average 6.5 per cent. Thus in these five groups is a minimum of 72.35 per cent. of all apparatus items, leaving the remainder, 27.65 per cent., to be divided among at least 11 groups, including "miscellaneous."

Boilers, foundations and settings can be estimated closely, as can also the condensing apparatus. Engines, foundations, piping and circulating-water systems present greater difficulties, relatively, about in the order named. It is possible to estimate as close as 3 per cent. on boilers installed; on engines, installed, 5 per cent.; on engine foundations, 10 per cent.; on circulating-water systems, 15 per cent.; on piping systems, 20 per cent.; on condensers, auxiliaries and foundations, 3 per cent.

Applying these percentages of error to the minimum percentages of the whole, the total probable error on 72.35 per cent. of the apparatus is as follows:

		Per cent.	
Boilers	17.25 × 3	= 0.52	(+ or —)
Engines	33.60 × 6	= 2.01	(including foundations)
Piping	7.00 × 20	= 1.40	
Condensers	10.00 × 3	= 0.30	
Circ. water system	4.50 × 315	= 0.68	
Total		4.91	

Assume for the moment that the total cost can be estimated as closely as 15 per cent., which percentage ordinarily includes 5 per cent. for contingencies and errors. If by concentrating attention on the five principal groups one can come as close as 5 per cent. on the larger items, and this is possible, then there is a leeway of about 43.5 per cent. on the remaining items. Certainly, in almost every case one can come within 20 per cent. on these items, and if so, the total estimate is within 8.5 per cent., as against the 15 per cent. assumed.

Herein have been used the minimum percentages for the principal items. In some cases this is as high as 85 per cent. If this is analyzed in the same manner as for the 72.35 per cent. the total estimate may be within 6.5 per cent.

Buildings for this apparatus vary from 6 to 16 per cent. of equipment costs, an average, say, of 10 per cent. Using unit prices, on a square- and cubic-foot basis, as well as for horsepower and kilowatt bases, checking each against the other, will probably keep the error within 10 to 15 per cent., a percentage of 1 or 1.5 on the total.

*Abstract of a paper published in the "Journal" of the Worcester Polytechnic Institute.

†Chief mechanical engineer, J. G. White & Co.

Detroit "300" Grease Lubricator

This lubricator is designed to feed grease, nonfluid oils, and similar lubricants evenly, economically and efficiently. The heating chamber of the lubricator is of sufficient size to reduce the lubricant in the reservoir to a liquid condition when steam is turned on.

Cold drafts, outside exposure or temperature variations do not affect the operation of the lubricator and the oil or grease in the lubricator is maintained in a fluid condition at all times with an even rate of feed and fine regulation.

The lubricator can be installed either with both connections between the boiler and the throttle or else with the condensing tube above the throttle and the delivery or support arm below the throttle. To permit either installation, there is attached to each lubricator a choke to be screwed into the support arm in case the connections are made on both sides of the throttle. If both connections are above the throttle, the choke is not required.

This lubricator is made by the Detroit Lubricator Co., Detroit, Mich.

ELECTRICAL DEPARTMENT

Meter Test Boards

By G. C. Cassard

In designing a switchboard for meter testing, two features must be given consideration: One is simplicity and cheapness in first cost, and the other is convenience, with the resulting cheapness in operation. Of these two factors, the latter is by far the more important, especially as the testing demand increases. However, where the meters are few and of small capacity, a simple board may be found advisable. This type will be considered first.

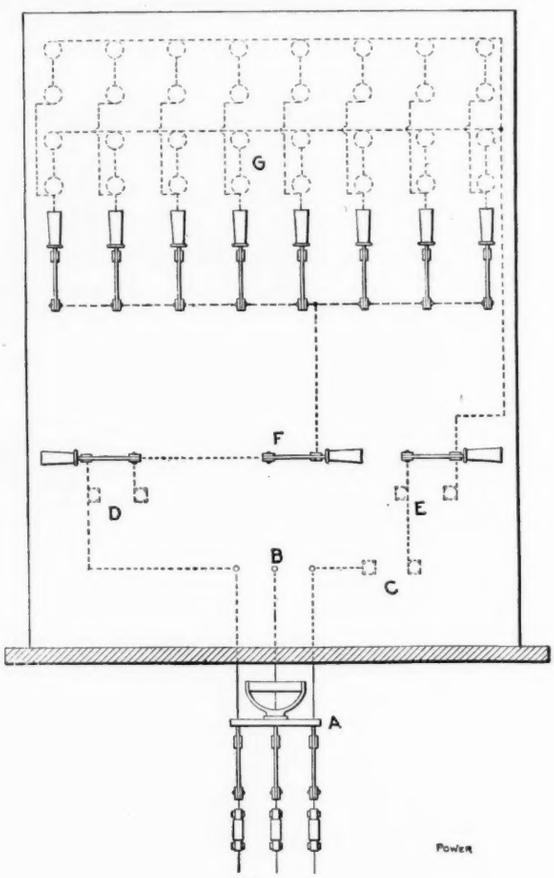


Fig. 1

The switchboard proper (Fig. 1) is supported about 2½ ft. above the floor by an iron frame, extending forward at this point to support a wooden work table. The meter to be tested is hung on a small portable frame set up on this table.

The service is in this case single-phase, three-wire and comes up from below to a main line switch *A*, mounted under the table, and which serves simply to cut out the board when not in use. The service continues to *B*, where three binding posts are provided for taps from the meter potential circuits. From this point on, the neutral is discontinued, the load being designed to operate on 220 volts. At *C* is a pair of binding posts for connecting in the standard instrument; *D* and *E* are two more pairs of posts provided with short-circuiting switches; *F* is a switch for opening and closing the circuit, and *G* is a bank of lamps.

In testing two-wire meters, either *D* or *E* may be used for the current connection, but the one not used must be short-circuited by its switch as shown.

Three-wire meters are connected at both *D* and *E*, the two field coils being fed by the opposite sides of the system. This is a very desirable feature and one that has been given little attention in switchboard design. It

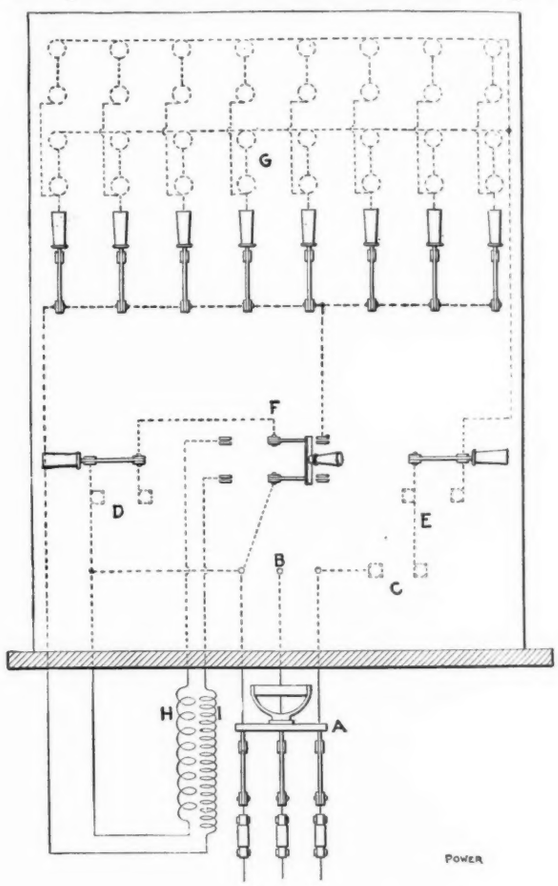


Fig. 2

has been the usual practice, in testing these meters, to connect the two fields directly in series by using a short wire jumper. The fields are thus brought to the same polarity, the disadvantage of which arrangement is apparent. The potential circuit is normally tapped from the same terminal blocks as the fields, and it becomes necessary to disconnect one of these fine pressure wires and attach it to a temporary tap taken from the other side of the system. With the arrangement shown in Fig. 1, this work is unnecessary, the load being in circuit between the fields, just as is the case when the meter is in service.

Provision is also made in this, as well as in the other

three sketches, for bringing the potential tap for the armature circuit to the left post of each pair of binding posts, as the service is supposed to be on the left in all these cases and the armature tap must be on the service side. In most test rooms a current range of at least 200 amp. is occasionally required. A large capacity may be provided by artificially loading the test circuits without actually making a demand on the outside service in watts indicated.

In Fig. 2, this provision is made for increasing the load by means of a step-down transformer *HI* having a ratio of 10 to 1. With the switch *F* thrown to the right, the arrangement is the same as that in Fig. 1 with no transformer in circuit, with the load between the two pairs of posts *D* and *E*. When the switch is thrown to the left, however, this latter advantage is lost—the meter can be connected only at *D*. But the secondary, *H*, of the transformer is now in local circuit with the meter, while the primary *I* is fed from the line through *C* and *E* and the lamp bank. As the load on the bank is increased, its resistance is reduced, thus throwing a greater difference of potential across *I* and consequently across *H*. One side of the armature potential is given by the tie between the primary and secondary shown just above the transformer, and the other tap must be taken off independently at *B*.

It must be remembered that, in testing meters by the use of a transformer, the nameplate ratio is not to be considered constant. The standard instrument is on the primary and the meter under test on the secondary, and their exact ratio should first be determined under various loads and the results plotted, or a table of constants made up.

Figs. 3 and 4 are the same, with the four-blade switch *F* in different positions to make it simpler to trace the circuits. Here is an advantage that was lacking in Fig. 2—the meter fields are on either side of the system, and each field is provided with armature pressure, whether it is directly on the service (Fig. 3), or on one of the transformer secondaries (Fig. 4). The double secondary is necessary here, of course, because the two halves must be at a difference of potential of 220 volts.

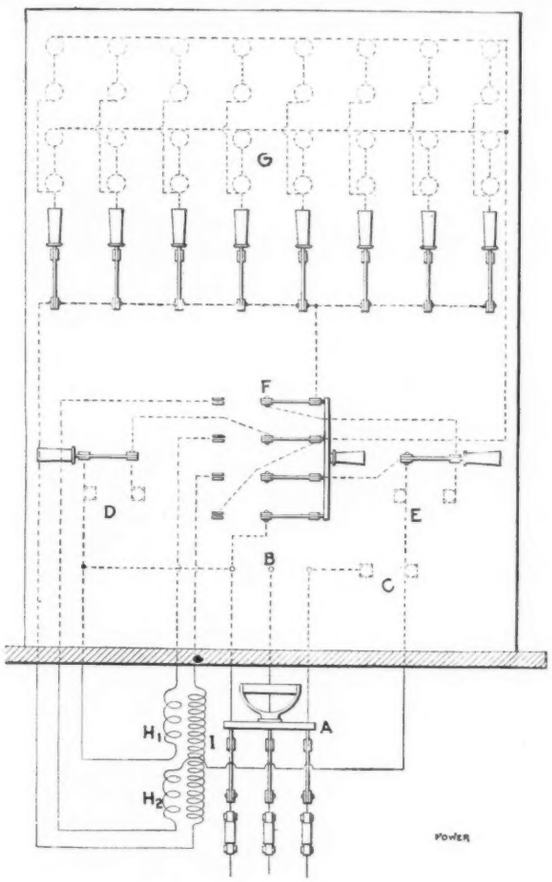


FIG. 3

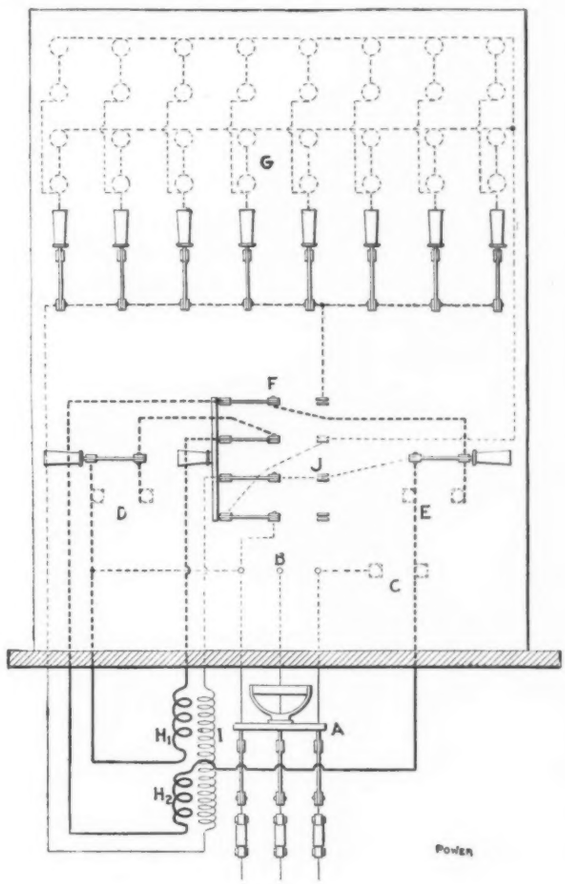


FIG. 4

These two secondary circuits are shown in Fig. 4 in heavy lines and are so arranged with relation to the primary and to each other, that the meter fields will not oppose each other.

That part of the right-hand circuit between *C* and *E* is common to both primary and secondary, and the alterations are momentarily in the same direction.

In the third pole *J* of the four-pole switch, a short jumper ties the clip and base of the blade permanently together on the right side only, but the blade is free to swing with the others.

No "phase splitting" arrangement is shown as it is not a necessity in most test rooms. It may be very simply provided by running in additional pressure wires from taps on the service transformers, thus displacing the phase angle of the voltage rather than that of the current. The primary service is, therefore, brought up to the transformers two or three phase as the case may be, while the secondary service (shown in the drawings) is single phase, as stated.

GAS POWER DEPARTMENT

First American-Built Marine Diesel Engines

The first and only marine Diesel engines to be built in this country are being constructed by the New London Ship & Engine Co., of Groton, Conn. For several years this firm had built gasoline engines for the submarines of the United States Navy, but took up the construction of Diesel engines about two years ago, when the Government specified this type of motor for the submarines then authorized.

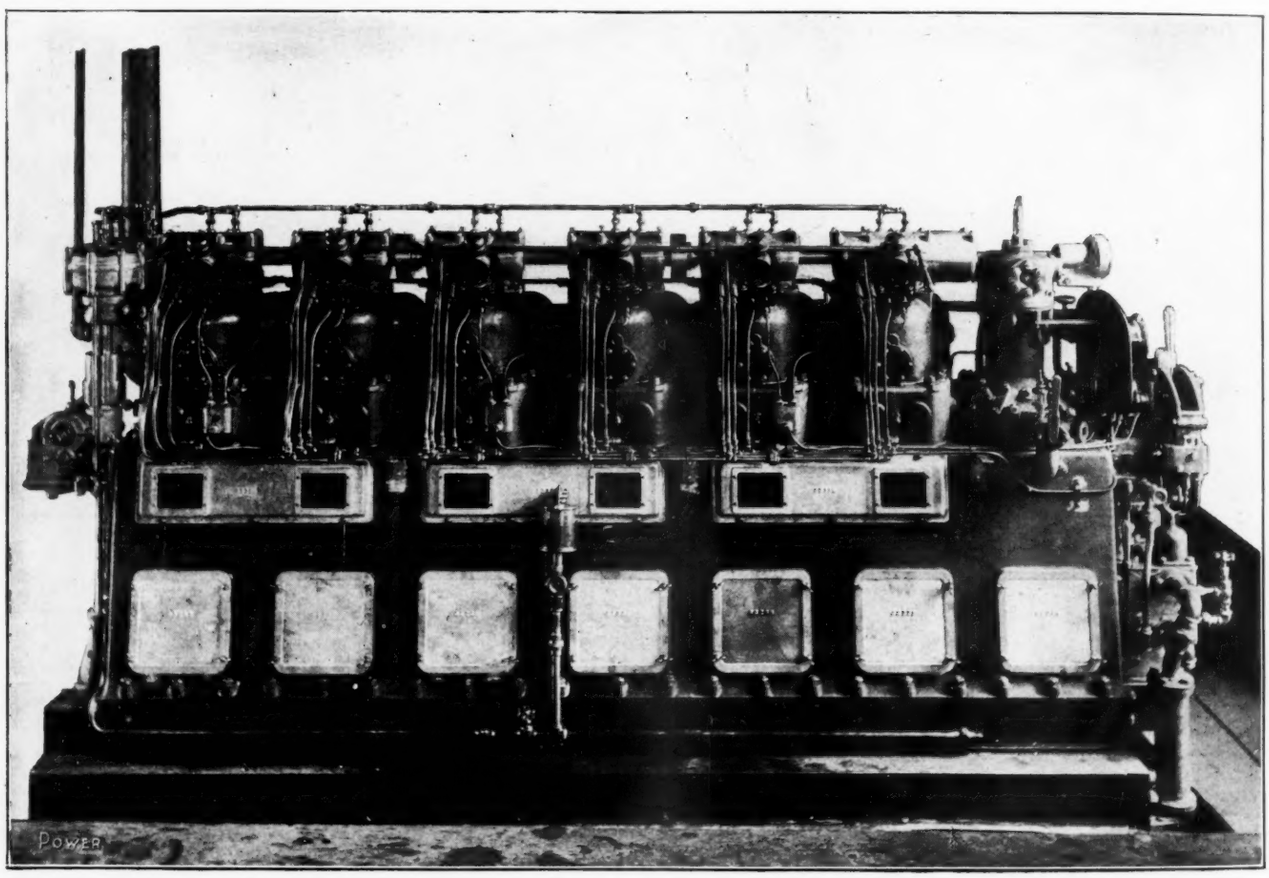


FIG. 1. SUBMARINE TYPE OF ENGINE

The engines are of the Nürnberg two-stroke-cycle type, with slight modifications to meet local conditions. As built for the submarines, they are of the light-weight, high-speed type, 450 hp., six-cylinder, 11x12½ in., and run at 450 r.p.m. Fig. 1 shows one of these engines on the erecting floor.

Taking up this type somewhat in detail, attention is called to Fig. 2, which represents a section through one of the cylinders. The scavenger piston is integral with the working piston, the effective area of the former being about 1.5 times that of the latter. Since they have a common stroke the volume of free scavenging air is about 1.5 times the displacement of the working piston.

In the position shown the piston is on the downward or power stroke, the fuel supply having been cut off and expansion of the gases taking place. At the same time air is being drawn into the scavenger cylinder through the suction valve. When the top of the working piston reaches the upper edge of the exhaust port, the gases begin to escape into the exhaust pipe. Shortly before the lower dead center is reached the scavenger valve is opened by the cam and scavenging air enters the cylinder from the receiver, where it has been stored during the previous stroke. This not only clears the cylinder of burnt gases, but also furnishes fresh air for the compression stroke. The scavenger valve remains open until the exhaust port is covered on the upward stroke.

Considering now the upward stroke, it is obvious that compression begins in the working cylinder as soon as the exhaust port is covered. At the same time, however, in the scavenger cylinder, the suction valve (which opens inward) automatically closes and the discharge valve (which opens outward) opens. Hence, the charge of scavenging air is forced through the discharge valve and

into the scavenger receiver, where it is held under pressure until the scavenger valve opens on the next stroke.

Compression is carried in the working cylinder to 500 lb., and fuel is injected through the spray valve a few degrees before the upper dead center, and is continued for about one-tenth the power stroke. A two-stage compresor driven off the main shaft (shown at the right, Fig. 1) supplies air at about 1000 lb. for fuel injection.

Starting and Reversing

Starting and reversing are effected by compressed air, normally at 800 to 1000 lb., although the engine will start when the pressure in the starting flask drops as low as 225 lb. The starting valve is in the head of the

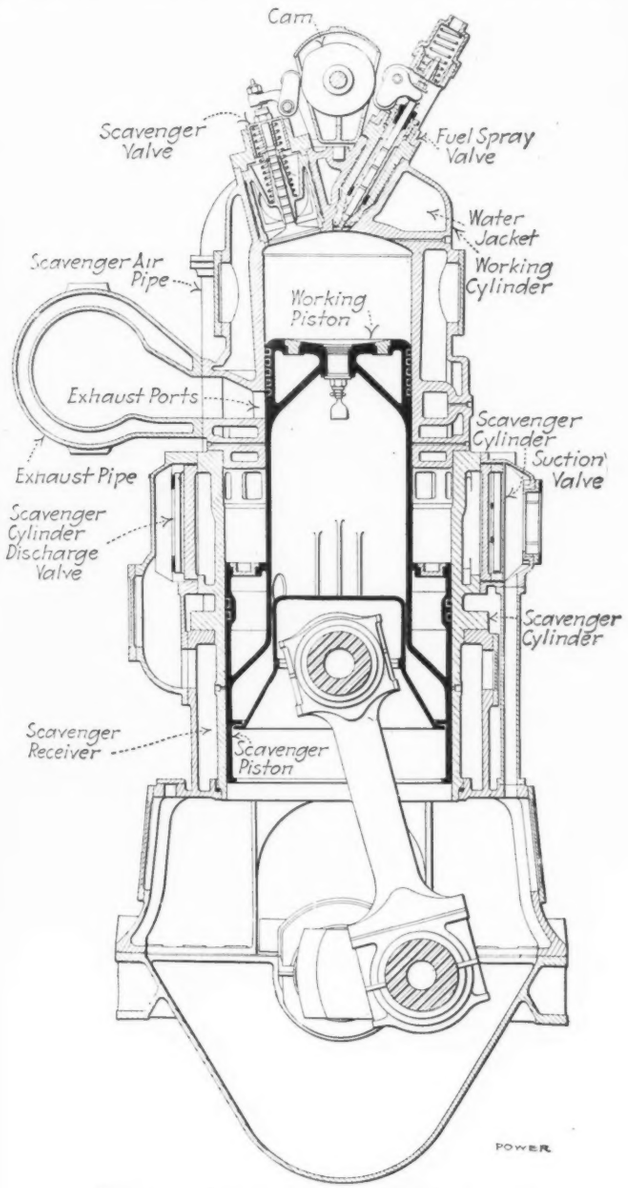


Fig. 2. Section through Cylinder

cylinder, just back of the scavenging valve, Fig. 2. A single movement of the control lever or wheel performs the operation of starting, stopping, reversing and changing speed.

The air starting and reversing system is represented diagrammatically in Fig. 3. Air is supplied from the starting flask to the balanced relay valve, flowing through the pipe A to the ahead and the backing-control valves also through the restricted pasage X and the pipe B to the trip valves.

Assuming that the engine is to be started ahead, the control wheel is turned to the right and through a worm

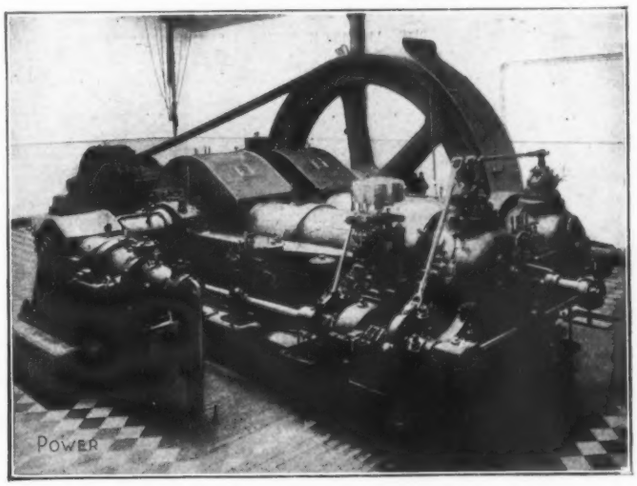


Fig. 3. Stationary Horizontal Type

operates the arm M. This first presses down the plunger P_1 of the trip valve and allows air to escape through the vent. The sudden release of air and the restricted passage X produces an unbalanced presure in the relief valve and causes this to open against the spring, admitting air at high pressure through the pipe D to the starting valves in the cylinder heads. These valves, however, are balanced and for the present remain closed under pressure.

Further movement of the arm M presses down the plunger P of the ahead control valve. This admits air through the pipe E to the distributing valves (one ahead and one reverse for each cylinder), the plungers of which are in contact with the respective cams on the camshaft. This provides a method of selection whereby only that distributing valve, corresponding to the cylinder which has its piston at the proper part of the cycle for starting, will open and admit air to the starting valve. This produces an unbalanced pressure in the starting valve, opens it and admits the bulk of the air from the pipe D, and the piston is forced down. The other distributing valves are opened in turn, admitting air to the other cylinders.

When it is desired to start the engine in the reverse direction, the wheel or control lever is thrown to the left and through the link N operates the astern trip and control valves, the operation being similar to that described for ahead, except that the astern cams and distributing valves are now brought into use.

When the engine is running ahead and it is to be reversed the control lever in being brought back to the central position shuts off the fuel supply; further movement to the left reverses the engine by admitting compressed air as stated and then the fuel is automatically turned on. A brake valve shown at the extreme right automatically relieves the pressure in all the working cylinders before the engine can be started ahead or reversed. A forced-feed system of lubrication is employed.

The light-weight engines of this class designed for naval service, weigh from 50 to 60 lb. per horsepower,

including all auxiliaries, and their fuel consumption is about 0.5 lb. per b.hp.-hr.

For merchant service these engines are made in a heavy slow-speed type, the weight in this case being about 97 lb. per hp. and the speed ranging from 165 to 375 r.p.m., according to the size. The fuel consumption of these heavy slow-speed engines is slightly less than that of the light high-speed type.

Twenty-two of the lighter type of engines are either under construction or have been delivered to the United States Government, and four are nearly completed for the Chilean government. Besides this, one has been installed in a barge for the Standard Oil Co. and another in the yacht "Idalia."

The New London Ship & Engine Co. expect shortly to extend their field to that of the stationary Diesel engine, the type to be put out being shown in Fig. 4.

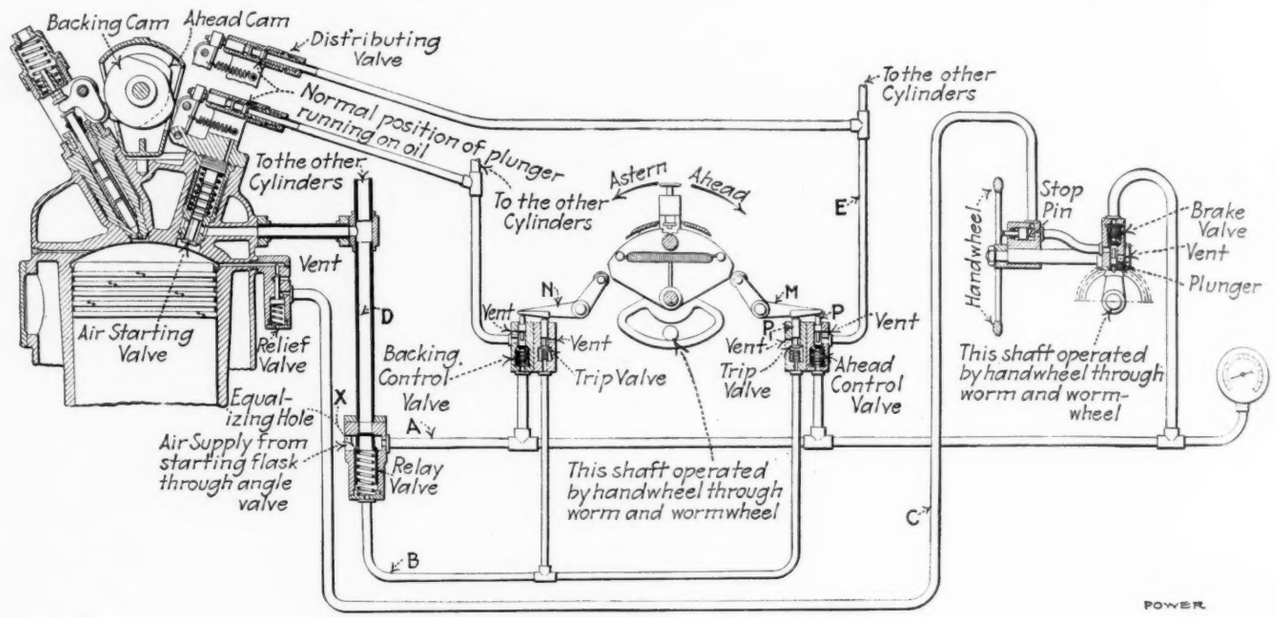


FIG. 4. STARTING AND REVERSING SYSTEM

Gas-Engine Silencers

The most common method of silencing the exhaust of a gas engine appears to be to turn the exhaust into a box whence another pipe is carried to a pit in the ground. This is often filled with loose stones and a final outlet to the atmosphere must be provided to let out the spent gas which otherwise would accumulate in pressure. All these contrivances produce back pressure on the engine.

Perhaps too few of us record our failures in this and other matters. Too late I found out that the Germans had thought out the same idea that I recently put into practice. Wishing to silence an engine and reduce the back pressure instead of augmenting it, the 2½-in. exhaust was tapered up to 3 in. and turned at a fair radius around a corner. Then it tapered up to 4 in. diameter and entered the end of a cast-iron pipe which tapered again from 4 in. up to 7 in. in its length of 9 ft. For about half the length of this pipe a V-slot was cast in each side. The ideas embodied were that the gas should expand gradually into a pipe seven or eight times the original area, reducing its velocity and also permitting it to escape by the V-slots over a length of nearly 4 ft. before reaching the final outlet.

Instead of silencing the exhaust, the tapered pipe seemed rather to act as a megaphone.

The next attempt was to continue the 4-in. pipe at a smaller diameter inside the cast-iron pipe, perforating the new length with numerous holes of an aggregate area considerably greater than the cross-sectional area of the pipe. This did not appear to have the slightest effect and since it was not desirable to delay matters, the exhaust pipe was carried below the floor and into the conventional box placed in a large brick pit, which was vented through a long 4-in. shallow drain to a ditch.

It has not yet been possible to try a new idea which the foregoing failure suggested. It seemed when watching and observing this that the sound, loud as it was, did not travel well around a corner. This suggests that if the exhaust could be carried to a brick well built, if necessary, above ground the noise of the exhaust would go skyward and would be hardly audible at any distance laterally. Something less resonant than cast iron would probably be better. A cone of brickwork stood vertically in a pyramid of clay might serve.

An old engineer suggests that the exhaust should impinge on the point of a cone supported by a light spiral spring in an enlarged chamber as near as possible to the engine. The work of the gas would, he declares, be expended on moving the cone and the cone would spread the gas round its periphery in a thin annulus.

There is very little noise from the exhaust of a motor car when the cutout is closed. These have an effective system but possibly considerable back pressure is at the same time set up. A favorite motor-car silencer is a box three or four times the diameter of the exhaust pipe and containing several perforated division plates of increasing fineness in series. These cut up currents of gas until it escapes in a continuous mass of fine streams. But this is merely curing by obstruction and is not a direct method such as it may be hoped will be ultimately discovered.

London, Eng. WILLIAM H. BOOTH.

HEATING AND VENTILATION

District Steam Heating with High-Pressure Steam*

By Frederick W. Ballard

When the heating of small or moderate-sized factories is under consideration where the buildings to be heated are within a radius of a few hundred feet from the power house, and where the size of the power plant is under, or at most not much in excess of 1000 kw. capacity, then it is more economical to operate the power plant with simple noncondensing engines and use the exhaust steam for heating purposes. The heating plant should be operated under a vacuum system and the back pressure on the engines maintained at practically that of the atmosphere. In such a plant, a charge for the heating should be made to the departments served, and a corresponding credit given to the power plant of about 12c. per yr. per sq.ft. of radiation. The cost of power in a plant of this kind can then be reduced to about 1.5c. per kw.-hr.

In large central stations, operating large condensing steam turbines, and with modern highly efficient equipment throughout, power can be generated for ½c. per kw.-hr., or even less. In such installations it is not good practice nor is it economical to try to run engines or turbines noncondensing for the purpose of securing exhaust steam for heating purposes, or for any other purpose. Due to the backpressure it is only possible to secure one-half or even less than one-half the power from a noncondensing engine or turbine which could have been secured from the same amount of steam; and this fact must not be lost sight of when considering the advantages of an exhaust-steam low-pressure heating system.

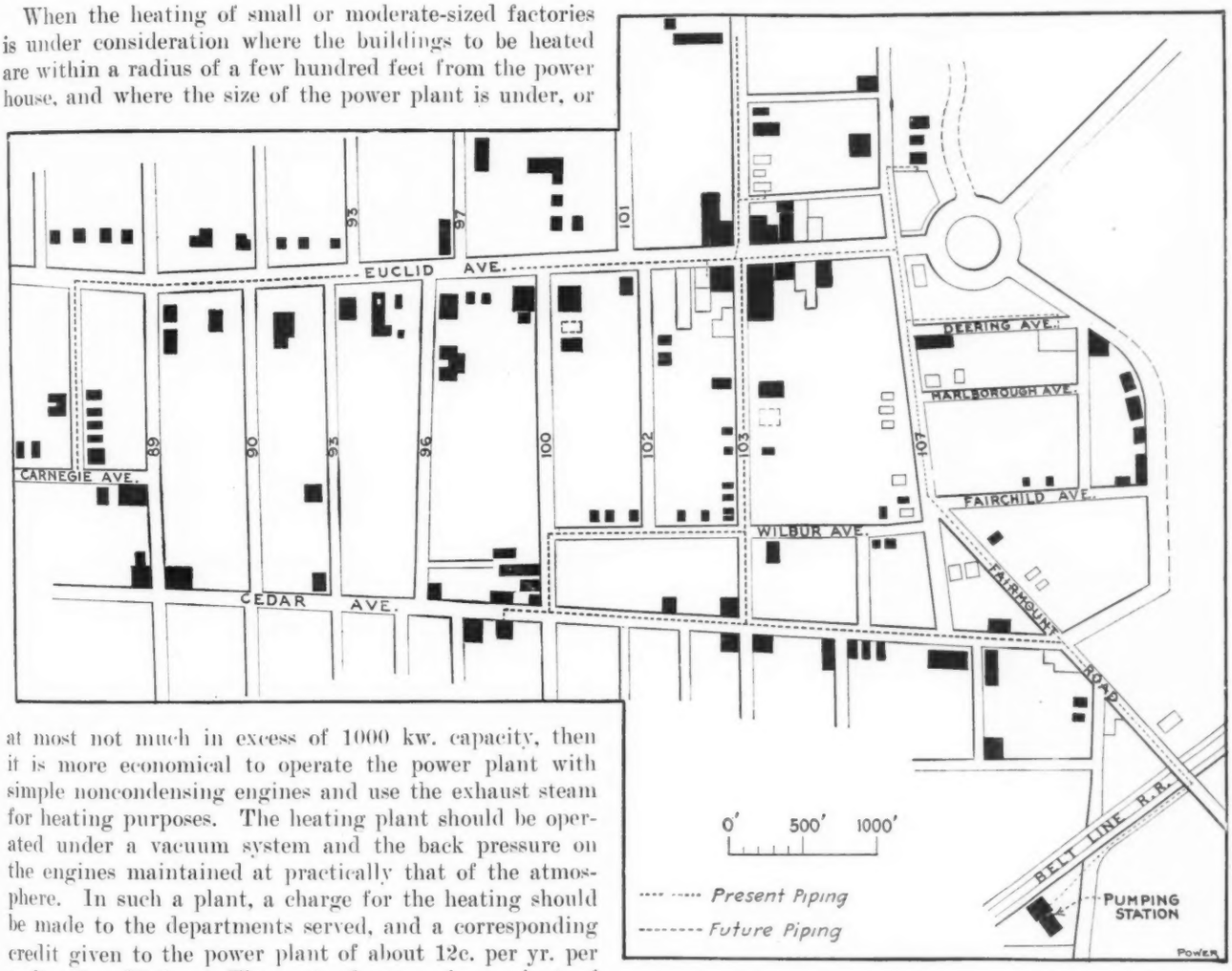


Fig. 1. Map of Complete District

The greatest advantage of a high-pressure system is the much lower investment required by the smaller mains. Another advantage is the lower percentage of heat loss in the mains due to the higher velocities and the smaller amount of surface.

With these ideas in mind we have undertaken in the city of Cleveland the installation of a high-pressure heat-

TABLE I. HIGH-PRESSURE DISTRIBUTION SYSTEM

Section of Main	Approx. Length of Section, Ft.	Hp. of Steam through Main	Dia. of Main, In.	Velocity of Steam per min.	Drop in Steam Press., Lb. per Sq.In.	Mean Density, Lb. Steam per Cu.Ft.	Mean Spec. Volume, Cu.Ft. per Lb. of Steam
Fairmount Pl. to Cedar Ave.	2000	2500	10	7875	125 — 107 = 18	0.29	3.42
Cedar Ave. to Euclid Ave.	2000	2000	10	7100	107 — 94 = 13	0.261	3.83
107th to 105th	700	1500	8	9360	94 — 84 = 10	0.236	4.24
105th to 96th	1500	1000	8	7000	84 — 74 = 10	0.214	4.67
96th to end of line	2000	500	6	6800	74 — 57 = 17	0.186	5.36

*Abstract of paper read before the Ohio Society of Mechanical, Electrical and Steam Engineers, Springfield, May 22.

ing system, in which we expect to distribute steam to greater distances and in larger quantities than would be financially possible with low-pressure steam.

In Fig. 1 is indicated the portion of the district already installed and in operation during the latter part of the season just closed, also the district it is expected to serve on the completion of the system at the beginning of next season. Table 1 gives the principal data of the system.

The amount of steam passing through the main in horsepower is based on 30 lb. of steam per hour per horsepower. The initial pressure is 125 lb. per sq.in., and under the conditions shown in Table 1 there will be about 57 lb. pressure left at the end of the main. The drop in pressure for each of the different sections was found by the following formula:

$$P = 0.0001321 \frac{W^2 L \left(1 + \frac{3.6}{d}\right)}{y d^5}$$

where

P = Drop in pressure in pounds per square inch;
W = Weight of steam in pounds per minute;
L = Length of the pipe in feet;
y = Mean density in pounds per cubic foot;
d = Diameter of the pipe in inches.

The mechanical features of a high-pressure system are not difficult. Since higher temperatures are involved, the question of heat insulation becomes more important than in a low-pressure system. The expansion must be carefully taken care of and ample safeguards must be provided in the pressure-reducing valves so that by no possibility can the high pressure find its way to the customer's radiators.

In Fig. 2 are shown the details of a manhole in which an expansion joint is installed. This is a double-slip joint, which is installed every 400 ft. Half way between these expansion joints the pipe is rigidly anchored to heavy concrete blocks and from the anchor to the expansion joint the pipe is carried on rollers in an absolutely straight line. Wherever there is a bend in the line in either a horizontal or vertical direction, the pipe is again anchored securely to take care of any thrust due to the unbalanced pressure.

In Fig. 3 are shown the details of a manhole in which connections are made for steam to the service or low-pressure mains. Sometimes these low-pressure mains serve only one customer and sometimes several who may be grouped closely together. It may be noticed that two reducing valves in series are installed for these connections. The first one is set to regulate the pressure in the service main at 10 lb. The second valve is set to operate at 15 lb., and is intended to come into operation only on failure of the first valve. These second valves are tested regularly by the inspector by holding the first valve open until the pressure in the service main builds up to 15 lb. The second valves being open under normal conditions, the valve seats are always in good condition and the diaphragms do not wear out.

A section of the trench illustrating the method of heat insulation and of draining any water in the soil away from the main, is shown in Fig. 4, and in Fig. 5 the details of the sylphon regulating valve, which is installed in the basement of each individual customer. In addition to the means which this provides the customer for regulating his individual service, it also provides an additional protection against the high pressure finding its way to the radiators. The details of the installation on the customer's premises are shown in Fig. 6. In some instances a regitherm is installed in connection with the sylphon regulating valve, for automatic regulation. This has been found in some cases to reduce the steam consumption by as much as 25 to 30 per cent., as well as relieving the customer of the inconvenience of hand regulation.

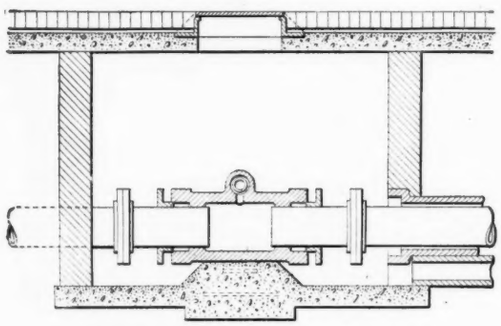


FIG. 2. DETAILS OF MANHOLES, SHOWING EXPANSION JOINT

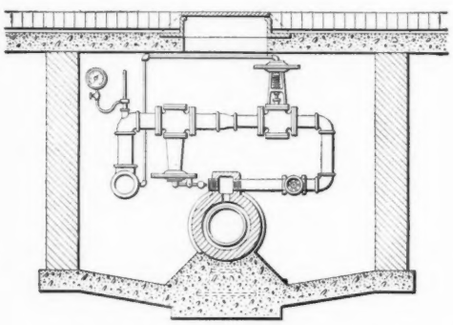


FIG. 3. CONNECTIONS TO LOW-PRESSURE MAINS

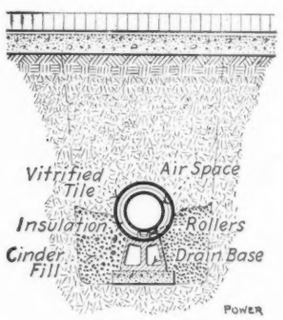


FIG. 4. SECTION THROUGH TRENCH

In making a comparison of the size of pipe required for high- and low-pressure systems, one is confronted by the fact that the friction in the pipe varies inversely as the fifth power of the diameter, and that provided a pipe of double the diameter is used the friction is thereby reduced 32 times. The drop in pressure is thus reduced so much by using a slightly larger pipe, that at first sight it might appear as a fallacy to argue that it would be more economical to use high-pressure steam for reducing the investment by reducing the size of pipe. However, when the greatly increased cost of pipe and particu-

TABLE 2. LOW-PRESSURE DISTRIBUTION SYSTEM

Section of Main	Approx. Length of Section, Ft.	Hp. of Steam through Main	Dia. of Main, In.	Velocity of Steam per min.	Drop in Steam Press., Lb. per Sq.In.	Mean Density, Lb. Steam per Cu.Ft.	Mean Spec. Volume, Cu.Ft. per Lb. of Steam
Fairmount Rd. to Cedar Ave.	2000	2500	24	5600	15 — 13 = 2	0.074	14.03
Cedar Ave. to Euclid Ave.	2000	2000	22	5770	13 — 11 = 2	0.069	15.00
107th to 105th	700	1500	18	6700	11 — 10 = 1	0.064	15.79
105th to 96th	1500	1000	18	4730	10 — 8 = 2	0.062	16.76
96th to end of line	2000	500	14	4500	8 — 5 = 3	0.057	19.31

larly the increased cost of valves and fittings when the size is doubled is considered the saving in the investment acquires importance.

For the purpose of comparison, assume a pressure of 15 lb. per sq.in. at the Fairmount Station, and by allowing 10-lb. drop, there will be 5 lb. left at the end of the line, 8200 ft. away. This would be necessary to give satisfactory and reliable service.

For computing the diameter of pipe necessary for each of the sections considered above the following formula was used:

$$d = 0.2 \sqrt[5]{\frac{W^2 L}{Py}}$$

This formula gives the sizes of pipe for the various sections of the distributing mains, as shown in Table 2.

It is interesting to notice that although the pipe sizes are about 2½ times those for the high-pressure mains, the velocity in the low-pressure mains is nearly as great. This is due to the difference in the density of the steam at the different pressures. The costs of installation for both the high- and low-pressure mains are given in Table 3.

The total cost of the mains for the low-pressure distribution system are shown to be about 2½ times the cost of those for the high-pressure distribution system, and means an extra investment of something over $100,000. A conservative allowance for the fixed charges on this extra investment would be 10 per cent., including interest, depreciation, taxes, etc. This means an annual charge of $10,000 against the low-pressure system, over and above the fixed charges against the high-pressure system.

Of course, the reason for the use of low-pressure steam in heating systems is that the steam is first used for the generation of power and the exhaust steam is then used for heating purposes. However, when it is desired to transmit steam to considerable distances, it becomes necessary to carry at least 15 lb. back pressure on the engines. This reduces their efficiency greatly and adds to the importance of the question as to whether it might not be more economical to operate the power station condensing with maximum efficiency and use live steam for the heating requirements. It is seldom, if ever, the case that the heating requirements coincide with the power requirements, and the problem of regulating the load between condensing and noncondensing units, so that the amount of exhaust steam would be just right is difficult. If this is not done then there is likely to be a loss due to exhaust steam going to waste, or, on the other hand, having to supplement with live steam under low-pressure conditions. Leaving this factor out of the consideration, a comparison between the two different methods might be made as follows:

TABLE 3. COST OF MAINS

High Pressure	
4000 ft. of 10-in. pipe	$4,200
2200 ft. of 8-in. pipe	1,761
2000 ft. of 6-in. pipe	1,128
Valves and fittings	15,000
Pipe covering and drain base	11,300
Excavation and back fill	10,560
Pipe fitting (labor)	4,300
Miscellaneous material, concrete, lumber, brick, etc	8,200
Repaving at $1.15 per ft	9,100
Total cost	$65,549
Low Pressure	
4000 ft. of 22-in. and 24-in. pipe	$15,300
2200 ft. of 18-in. pipe	6,630
2000 ft. of 14-in. pipe	4,600
Valves and fittings	51,000
Pipe covering and drain base	48,500
Excavation and back fill	12,900
Pipe fitting (labor)	6,000
Miscellaneous material, concrete, lumber, brick, etc	12,400
Repaving at $1.25 per ft	10,000
Total cost	$167,303

Suppose a boiler installation of 2500-hp. boiler capacity such as is being installed at the Fairmount Station. This would be capable of giving 5000-kw. capacity at the switchboard with suitable condensing equipment and a rate of 15 lb. of steam per kw.-hr. This would include the operation of auxiliaries. With noncondensing engines or turbines a fair rate would be 40 lb. of steam per kw.-hr. It would then be possible to generate 1800 kw. with the 2500 boiler horsepower of steam and have about 80 per cent. of the heat left in the steam for heating purposes, but it would be necessary to use low-pressure steam with the necessarily larger mains. This would necessitate the losses due to the larger investment and the increased heat losses due to the greater amount of surface. Only 36 per cent. as much power would be obtained with a consumption of 20 per cent. of the boiler capacity, leaving 80 per cent. of the boiler capacity for the heating, with the same consumption of coal and the same amount of steam produced in each case.

With an expenditure of 20 per cent of the heat value of the steam 1800 kw. of power has been secured. There is 2000 hp. of steam left to sell, having used 500 hp. to generate power which would have required 900 hp. of steam to produce, running the electrical generating equipment separately and with highly efficient condensing

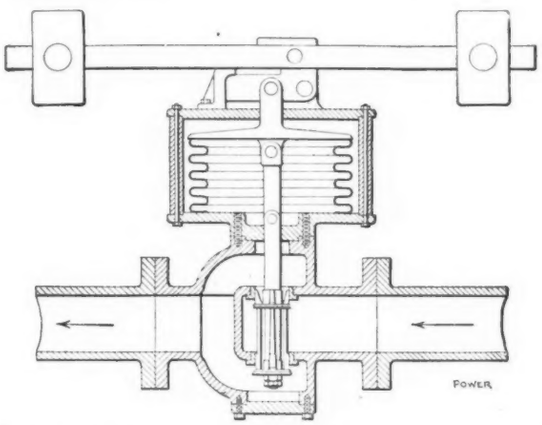


FIG. 5. DETAIL OF SYLPHON REGULATING VALVE

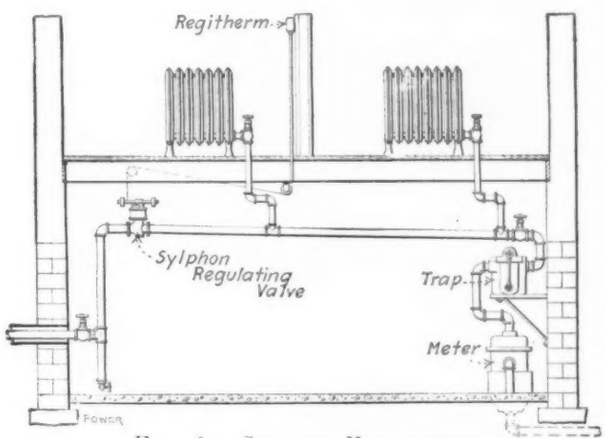


FIG. 6. SERVICE EQUIPMENT

apparatus. This analysis would show that the actual saving which has been accomplished is represented by the cost of producing 400 hp. of steam.

The 400 hp. of steam thus saved would have such a value as it would cost for its generation in a power station, and might be figured on a basis of 10c. per 1000 lb. of steam. The period of time for which the saving should be allowed would be for the six months of the heating season, and to be conservative assume that the saving goes on throughout the 24 hours of every day, although a 40 per cent. load factor on a central-power station is generally considered good. With these assumptions the saving amounts to $5250 per year, but it was just shown that the fixed charges on the extra investment for the low-pressure mains was $10,000. This one item alone costs nearly double what the saving would be from the use of exhaust steam.

There are other items of importance which militate against the exhaust-steam low-pressure system for district heating. The noncondensing engines or turbines cannot be operated economically during the period of time when the exhaust steam is not required for heating. This makes an extra investment necessary for power-generating machinery, the fixed charges on which are quite considerable. Also the impossibility of having the requirements for heating coincide with the requirements for power from a central station means, to say the least, an extra investment in machinery.

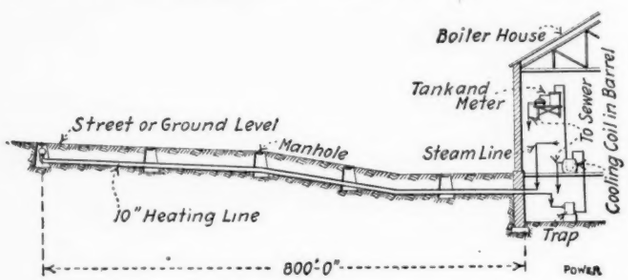


FIG. 7. DIAGRAM OF CONNECTIONS FOR TEST OF PIPE COVERING

There is also an advantage from the use of high-pressure steam, due to the great drop of pressure in the pipe. This does not represent a loss, but gives a tendency to superheat and the customer is supplied with dry steam. In the low-pressure system, there is a large percentage of moisture in the steam when it leaves the station, and to this is added the moisture due to the heat losses along the line. Finally, the losses in the pipe line are much greater in the low-pressure system because of the greater surface of the mains. Just what this amounts to, I have been as yet unable to determine. It certainly is not directly proportional to the square feet of surface, and this to a certain extent would be offset by the greater loss per square foot of surface in the high-pressure main, due to the higher temperature. Such tests as we have been able to make would indicate that, although there is a greater loss from the larger main, it is not in proportion to the square feet of surface, because of the effect of the surrounding earth, which itself acts as a nonconductor.

In Fig. 7 is shown a diagram of the connections for a test on the pipe covering which was made last November. The first 800 ft. of the 10-in. pipe was dead-ended and a pressure of 65 lb. was maintained for about ten days. An efficiency of the pipe covering was found such that the loss amounted to 85 per cent. of the loss which would have been found with bare pipe. There is certainly an opportunity for great improvement in the methods at present obtainable for the protection of underground steam mains.

The question naturally arises as to the limit of pressure which would be justifiable. Table 4 shows the data for 250-lb. pressure through the first two sections of the 10-in. mains of our system.

TABLE 4. DISTRIBUTION SYSTEM UNDER 250-LB. PRESSURE

Section of Main	Approx. Length of Section, Ft.	Hp. of Steam through Main	Dia. of Main, In.	Velocity of Steam per min.	Drop in Steam Press., Lb. per Sq.In.	Mean Density, Lb. Steam per Cu.Ft.	Mean Spec. Volume, Cu.Ft. per Lb. of Steam
Fairmount Rd. to Cedar Ave.....	2000	3700	10	6200	250 — 200 = 50	0.57	1.75
Cedar Ave. to Euclid Ave.....	2000	3000	10	6000	200 — 160 = 40	0.47	2.14

The drop in pressure in the two sections is shown to be about 2½ times that with the 125-lb. system and with only about 50 per cent. increase in the quantity of steam flowing through the mains. This is because the friction varies directly as the square of the weight of steam through the main. The density does not change so rapidly at this high pressure as the pressure increases. This, taking into consideration the difficulties connected with the generation and handling of high pressures, would seem to set the practical as well as the economical limit at from 200 to 250 lb. pressure for a high-pressure district heating system.

Downward Ventilation in a Rockford School

An abstract of Clinton E. Beery's paper on the above subject before the American Society of Heating and Ventilating Engineers was printed in POWER, Mar. 4, 1913, page 301. In the course of the discussion of his paper, the author added the following information in reply to questions asked regarding the unique system:

The humidifier used in this installation was a simple iron water pan, containing a submerged pipe with a series of petcocks along it. We used low-pressure steam to heat the water, the steam valve being under thermostatic control. This arrangement permitted the passing air to take up a certain amount of saturated steam with it.

A ceiling outlet is not necessary; in fact would never be open during the time that the room was occupied for school purposes. If it were necessary to fumigate a school room, with, say, formaldehyde, the smoke would spread to all parts of the room and if outlets were open at the top and bottom and the fan started, the odors would be quickly dispelled.

There is a decided advantage in placing the heating coils on the ceiling, which is that it reduces the temperatures at the ceiling. The ceiling coils are not intended to be used for heating the room, but for preventing too high temperatures up where they are unnecessary. With outside temperatures ranging around 45 to 50 deg. F., ceiling radiation need not be used as it is not necessary to prevent high final temperatures in the ventilating air. When the temperature gets down to 30 deg. and lower, the radiation on the ceiling is a decided advantage and the benefit is correspondingly increased as the outside temperature continues to go lower or remain low.

Regarding the by-passing of the incoming air to the vent flues, we took a low-pressure steam line and admitted steam to the room until it was completely filled. When that steam blanket got to a low level there was no more reason why it should not go over to the vent flues at the four corners than that the air should do so. But one could not find any place in the room where the density was not uniform. There was absolutely no lateral movement except down considerably below the desk tops.

EDITORIALS

The Price of Gasoline and Oil

In an article entitled the "Gas and Kerosene Situation," the *Scientific American* says:

United States Government reports show that the advancing price of gasoline is due solely to inevasible laws of supply and demand. No corporation or combination of corporations is responsible for the fact that demand has overtaken production, and that further increases in prices are now impending.

The United States government reports do not show that it costs 60 per cent. more to produce gasoline this year than it did last, nor any more for that matter.

There is no question but that the producers made a generous profit at last year's prices. Only when a long-suffering people shall decree that prices upon such commodities shall be based upon the cost of production, and shall be only such as to pay a fair profit upon the investment actually employed in that production instead of what the traffic will bear, will the user of a gasoline or oil engine know how badly he is to be held up for his next fuel contract, and the engineer and power user be able to compare the economical advantage of liquid and solid fuel, internal-combustion and steam engines upon a stable and intelligent basis.

Engineers' Salaries

The inadequacy of the salary—should we rather say wages?—of the operating engineer is a subject of frequent comment, especially among members of the craft. The recognition of the engineer, socially and financially, has not kept pace with his growing attainments and responsibilities. It is only comparatively recently that there have been many plants which justified the employment of a man of wide attainment. Today the complexity of the power plant has become such that no mere laborer can keep it going, and the saving possible in a plant of even moderate size warrants the employment of a man who knows power-plant engineering.

The money paid to many of these men is woefully insufficient for the type. Heads of departments demanding much less executive ability, training, effort and responsibility command higher salaries in many lines. For much of this the engineers have nobody but themselves to blame.

In New York there has recently been completed the largest office building in the world. It has its own steam plant with all that that means in heating, ventilating, pumping, lighting, refrigerating, etc. The engineer of such a building must be a good deal of a man, and it should mean much to a man to be engineer of such a building.

Evidently many engineers thought so, for there was no lack of applications. One who offered to take it for $4500 says he was offered $1800, which munificent offer was also received and refused by others.

It is commonly reported that the present incumbent took it at that price. The agent of the building refuses to tell the exact amount but says it is "about $2400."

The man who takes a position like that of engineer of the Woolworth Building for $1800 a year does not only himself but every member of the craft an injustice. If he is big enough for the job he is worth more money, and ought to stand out for it. If he is not worth more than $1800 a year, he is not big enough for the place.

This job at this price will help to hold salaries in New York down to the present low level. Why should the employer who knows that such an immense building pays but $150 per month expect to pay his engineer on a comparatively insignificant plant more, or even as much; especially if he can get somebody—and he can— to take it for less?

Who was it who said that the world is prone to take a man at his own valuation of himself?

Studying Wiring Diagrams

In these days of conduit wiring, installations properly planned give little trouble, and their permanent character from the wiring standpoint gives the average engineer little to do in comparison with the demands upon early electric-plant operators in making up connections, soldering cables and arranging auxiliary conductors. At the same time it is important for the progressive engineer to understand the wiring in every plant for whose electrical apparatus he is responsible, and spare time cannot be better expended than in the study of local circuits and the puzzling out of their details.

The easy-going man gets along reasonably well, it is true, by always falling back upon the manufacturers for the details of connections to and from his more complex electrical apparatus, but he who aspires to the real mastery of his installation will not rest content until he has conquered these details once and for all time, and put them down in black and white for convenient reference.

In a modern plant, where the wiring is laid out far in advance of its actual installation, it is often a problem of great complication to make a complete wiring diagram on the premises after operation has begun. It is sometimes almost impossible to follow the course of electric circuits without the aid of the original plans, and there should be rare occasions for this. The engineer is entitled to full sets of plant drawings from the designers and manufacturers, and he is entirely within his rights in asking for copies of wiring diagrams of the original layout as an aid to proper operation and intelligent anticipation of future changes in the equipment and its arrangement.

But if he cannot obtain these, and in some cases such drawings are never completely assembled, he can set himself the fascinating and helpful task of preparing loose-leaf or sketch diagrams of specific systems of electrical service within the station. It is a mistake to suppose that all home-made wiring diagrams should show every wire and finally be massed together in one impressive but

bewildering effort to put the entire installation on a single twenty-four by thirty-six-inch tracing. In these days it is more important to possess accurate sectionalized information about the individual electrical systems in the plant, and the combination of such diagrams is largely a matter of personal taste, depending upon the size of the installation and the amount of time at hand for the work.

Economy is served by the use of single-line diagrams in place of the elaborate two- and three-phase line drawings formerly looked upon as necessary, and the detailed interior connections of apparatus units may well be omitted in system sketches in many cases. The manufacturers of voltage regulators, exciters, battery-charging equipment, motors and other more or less complex machinery almost invariably will supply detailed interior circuit drawings without cost to the engineer, and these can be transferred to a loose-leaf wiring book as occasion offers.

One set of drawings, for example, may show the diagrammatic arrangement of busbars, generator leads, oil switches and feeders, leaving the main switchboard or bus compartments; another set may show the connections in skeleton form of the local station-lighting circuits, and another set may give the outlined relations of the auxiliary power-motor leads and controlling switches.

Throughout all work of this kind the engineer should keep its object closely in mind, and that object is primarily the clearing up of every mysterious detail in the connections for which he is responsible. No better mental discipline exists than the study and composition of wiring diagrams. The work demands imagination, accuracy, perseverance and insight, and may well occupy the attention of ambitious engineers keenly alive to the benefits of looking deeply into phases of power-plant operation beyond the comprehension of the layman. Such work helps to fit a man for grappling with bigger problems and makes him a more valuable employee.

Mastering Details

The prominence given to executive responsibilities tends to obscure the faithful performance of detailed work. The daily tasks of the engineer are filled with details of equipment and operation which, individually, may be overlooked, but, collectively, often make or mar the reputations of the high-salaried officials under whose general jurisdiction they are performed.

It is absolutely necessary then to master details in order to attain any lasting individual or organized success. Cultivating enthusiasm for the drudgery of one's position will lead the man with a reasonable aptitude for his occupation and plenty of staying power to the plans of the expert and away from the level of mediocrity. And it may be put down at the outset that the reward of really mastering one's daily work comes with the knowledge that one is equal to the emergency, wholly apart from the question of pecuniary benefits.

With the busy engineer, as with everyone, days come in which his tasks seem anything but worth while; in which the familiar duties look shopworn and burdened with routine. At such times "every ship is attractive except the one in which we sail." This is the time which tests the man of purpose and requires an extra effort on his part to attack the problems which confront him with a determination to make every little detail of his work right, to leave nothing done in a slipshod way, and to dig deep down into the perplexities which beset him.

It may be that a new type of valve has been put into the plant under the pressure of necessity, leaving the engineer practically no time to study its fine points, or that an automatic voltage regulator misbehaves and spoils the chart produced by the curve-drawing meter. Here is the engineer's chance to make life miserable for the concern that manufactured the valve or regulator until it supplies him with drawings or photographs of the interior parts, and descriptive matter in print or verbatim, which he could not obtain under the stress of the installation. It is his duty to study the details at the earliest available hour, and it is only his neglect to do so which may properly be blamed.

Whether it is taking indicator cards, fitting pipe, stopping leaks or packing valves, the engineer's work is so much one of detail that the mastery of these tasks in large degree fits the ambitious man for larger responsibilities. It is the custom in many plants to lay upon the engineer's shoulders the troubles of the entire establishment, so that he sometimes wonders if he is not a cross between a janitor and a plumber. The wise man, however, will hesitate a long while before he refuses to perform the duty nearest at hand.

Less than three years ago the vice-president of a large railway company, then a rising executive assistant in the manager's office, made it his personal task to see to it that the president's chauffeur brought the former's car to the door of the hotel at exactly the right moment following the conclusion of every meeting, a duty which any $3 a week office boy could doubtless perform, but which the high-priced man took upon himself in his determined efforts to be of the utmost possible use in every way.

No, the details must be done properly if the work as a whole is to stand, and just as each inch of wire in a transmission line a hundred miles long must be continuous and without break for successful service, so must the chain of detailed jobs done one by one in the silent criticism of one's own judgment and loyalty to the best work that he knows, establish a reputation for reliable and skillful performance, which is the reward of the master of those little things so often scorned as mere details, but of such cumulative power in the efficiency of every industrial enterprise.

Available CO_2 Percentages

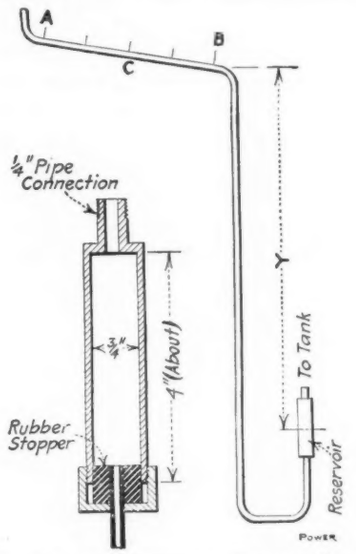
Flue-gas analysis is by no means common among engineers, and its popularity is not enhanced by the innocent symbols and terms met with in the use of the Orsat. Some of those with whom the practice does become popular overlook important factors influencing the maximum CO_2 available when burning fuels of different compositions. Failure to adequately consider and make allowances for these factors has been the cause of injustice to firemen ordered to maintain a standard percentage of CO_2 when burning coals of widely varying qualities.

Mr. Pohlman's letter, recently published on the subject of available percentages of CO_2, and the subsequent discussion on the subject have proved of especial interest and value.

READERS WITH SOMETHING TO SAY

Mercury Liquid-Level Gage

The writer recently had a cylindrical tank about 18 in. in diameter and 3 ft. high which was placed in an inaccessible garret used for the storage of crude oil. The oil was pumped up to the tank from an outside source and then allowed to flow back to a small burner used for house-heating purposes. Some means of telling just how



DETAILS OF MERCURY LIQUID-LEVEL GAGE.

much oil was in the tank was necessary. The sketch shows the apparatus used to do this.

A glass tube about ⅛ in. inside diameter was bent, as shown, and connected to a steel container or reservoir, the details of which are shown in the enlarged drawing. The apparatus was mounted on a board and placed in a vertical position on the wall in the room where the pump was situated. The upper end of the reservoir was connected to the pipe leading to the tank. The difference in level between the bottom of the tank and the mid point of the reservoir was about 20 ft. The distance *Y* was made of the proper length so that when the glass tube and the reservoir were filled with mercury and the oil was at its lowest level in the tank in the garret the mercury would rise to the point *B*. The part *C* was about 12 in. long and inclined, as shown, so that the mercury would rise to the point *A* when the oil tank was full. Knowing the capacity of the tank it was an easy matter to calibrate the distance *AB* to read in gallons.

Readers of POWER may have occasion to use some such device and for their convenience it may be stated that 0.884 in. of mercury will balance one foot of water. If the tube *C* is made one foot long, then for every foot depth of the tank the inclination of the tube *C* should be ⅞ in.

WILLIAM D. HALSEY.

West Chester, Penn.

Cannot Lubricate Pump

I have a duplex hydraulic pump operating a hydraulic press, the pump is of the slide-valve pattern, and steam to it is controlled by an accumulator. Steam at 110 lb. is delivered to the head end of the steam chest.

A mechanical lubricator was connected to the top of the valve chest and oil fed into the center of the valve chest though the top cover, the lubricator was controlled and operated by a rod which was bolted to the right-hand valve rod. By this arrangement it was found that the right-hand cylinder did not receive any oil while the left-hand cylinder received it all. On suggestion by the manufacturers, the connection was removed from the top of the steam chest and connected into the steam pipe 24 in. from the valve chest. The operating rod was taken off the right-hand valve rod and connected to the left-hand valve rod, still the right-hand cylinder does not receive oil while the left-hand cylinder is well lubricated.

The valves in both cylinders are set properly and there is no obstruction that would prevent proper lubrication. Both plungers are doing their share of work. I would like to hear some comment on this trouble.

J. B. LAKE.

Newark, N. J.

[So long as the operating lever has sufficient throw to give the proper stroke to the oil-pump plungers, it does not matter to which valve stem it is connected.—EDITOR.]

Fitting Crankpins in the Backwoods

Having seen occasional inquiries in POWER in regard to loose crankpins and the methods used to repair them, induces me to give some of my experiences with them.

Soon after going to work in a machine shop I was sent to a big sawmill to fit a new crankpin in a lumber gang, the old one being loose. The new pin, 5 in. in diameter and 14 in. long, was made with the tapered end considerably larger than the finished size, but so it would go about three-quarters of the distance through the crank disk; the taper was as near the right taper as we could get it. On trying it in the hole and testing for fit, we found the hole considerably out of round, and out of square.

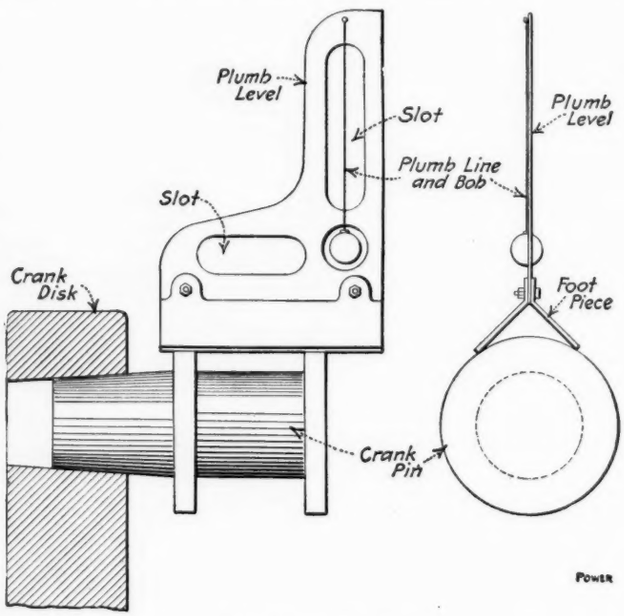
Coating the tapered end of the pin with red lead and oil, the pin was tried in the hole and rotated slightly back and forth. On removing the pin the high spots showed plainly and were dressed off with file and scraper. This was done repeatedly, gradually rounding the hole and at the same time dressing it, so as to bring it square with the crankshaft. We tested for square by using a tool called a plumb level made as illustrated. As the hole approached completion the shaft was rotated and placed on both dead centers and on the two quarters, and the pin tried for square in each position.

If, as the pin was gradually worked into the hole, the taper changed slightly or it was found to be too large, it was taken to the machine shop, which was near-by, and a

cut taken off in the lathe. This was done several times, care being taken to have the pin the proper distance in the hole when the fit was perfect. It was slow work with the frequent trials of the heavy pin and repeated turning of the shaft to get at the high spots. After the hole had been dressed to a near fit, fine emery and oil were used to grind down any slight inequalities in the hole, making a ground fit.

If the pin was still out of square as the hole approached a good fit, we set the crank so the weight of the overhanging end of the pin in grinding tended to work the hole in the proper direction.

In fitting the pin allowance was made for a shrink fit. The pin being finished and ready to be forced in the hole,



CRANKPIN LEVEL

the crank disk was heated by placing red-hot chunks of iron in the hole and changing them frequently, and by bent pieces of flat iron made red hot and placed on the outside of the disk and changed as they cooled. A heavy ram was also hung in a convenient position. When the disk was as hot as seemed advisable the pin was inserted and two or three blows of the ram were sufficient to drive it home, when the end was riveted over. This was my first job, but since then I have fitted probably twenty-five large pins and have never had a pin come loose.

I have fitted a few engine crankpins, where the old ones were loose, using this same method, and always found the holes out of square. Of course, this plan can only be used in a taper hole or by making a straight hole tapering, as I did, about four years ago, where the crankpin of a 22x48-in. engine came loose.

On removing the old pin it was found that the hole was originally parallel, but being both out of round and out of square, and no boring rig available, it was decided to put the new pin in by the method described. The hole was tapered by hand, using a temporary piece of iron to start the taper, and a lasting job was done. This crank was an arm instead of a disk and was heated to shrink in the pin by putting it on the outer center and placing a portable forge under it at the hole. The taper of these crankpin holes was about ¼ to ⅜ in. per foot.

At the place where so many pins broke, we got a cast-iron sleeve made the size of the pin, cast hollow to make it light, and used it to fit the pin. This saved lots of lifting in not having to use the heavy pin for that purpose. For grinding and rotating the pins we used wood or iron clamps with handles.

In using the plumb level the shaft should be level, or if a little out the plumb should show on the pin the same as when applied to the shaft.

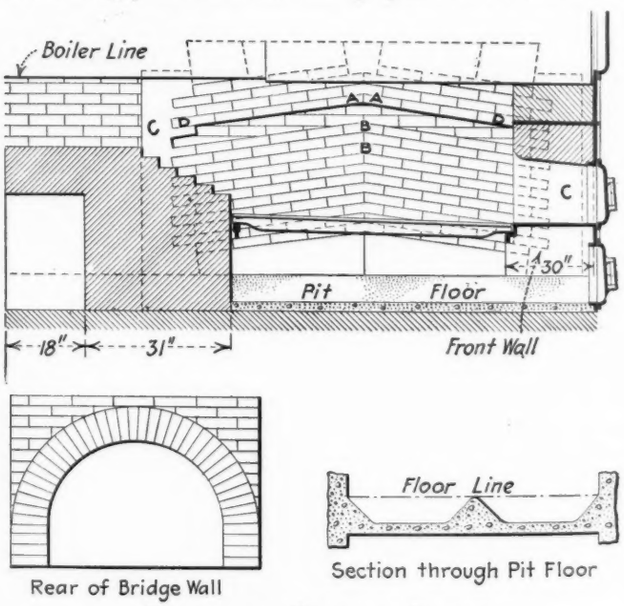
W. E. STICKNEY.

Prince Albert, Sask., Can.

Innovations in Furnace Walls

Has any reader tried laying the firebricks of furnace side walls in any other way than horizontally or perpendicularly? I know of one engineer who claims a marked improvement, and no small saving of time and outlay, by coursing the bricks as shown. He has also included in the design of his furnace other innovations, the most radical of which are depicted in the illustration.

The engineer's claims for his design are: No expensive skilled labor required; the key bricks *A* and *B* are made to order, and the pillars *CC* are so distanced that the bricks snugly fill the intervening space. As there is no



DETAILS OF FURNACE DESIGN

trimming to do, the least intelligent helpers, when aided by a guide, reaching from pillar to pillar, can lay the bricks satisfactorily; each course of bricks is self-contained, as shown at *DD*. The keys force the bricks snugly together.

Less material is used and the boiler is out of service but a short time during repairs. As the affected area is inclosed no time is lost in supporting the standing wall in making connections thereto, and it takes less time to dry the wall.

As to wear, the engineer showed me his log book, from which the following representative figures were copied:

Before the change:	
391 fire bricks at 3.5c	$13.68
Fireclay	1.50
Labor, mason, two days at 0.80 per hour	12.80
tender, two days at 0.50 per hour	8.00
Total	$35.98

The walls required repairing on an average of once in eight months.

After the change:

252 fire bricks at 4c	$10.08
Fireclay (some used for pointing other work)	0.40
Labor, two helpers, two days at $2 per day	8.00
Total	$18.48

The walls required repairing on an average of once in 13 months. The engineer claimed headers in the wall were not needed, as the bricks were so tightly packed they could not fall inward.

Other peculiarities of the design are the long bridge-wall top, to heat cold air when the furnace doors are open or a hole is burned in the fire; also, the ridged ashpit, shown.

There is one "improvement" the engineer is in doubt about. He is not certain of this innovation, but experiments seem to bear him out. He looks upon the furnace wall as a compound engine. The inner section, between the fire and the air space, corresponds to the high-pressure cylinder; the outer section, to the low-pressure cylinder, and the air space corresponds to the receiver. Now the higher the receiver pressure, the less will be the initial condensation in the high-pressure cylinder. Likewise, the higher the temperature of the air space, the less will be the loss of heat by conduction through the inner wall; for the transfer of heat by conduction varies directly as the temperature difference between the inner and outer surfaces.

It is admitted that more heat travels across the air space by radiation than would flow by conduction were the brickwork solid. From this, he reasons that if he covered one side of the air space with some smooth material, such as glass, the heat would be reflected back to the inner wall and its conduction through the outer wall checked. To cover the wall with glass being impracticable he has used the next best thing—bright tin.

He made tests of his theory by imbedding thermometer receptacles in the walls, and applying the instruments thereto, whose readings proved so complimentary that he had all the air spaces lined, but whether the result is due to the reflection of heat from the tin, to the diminution of air leakage through the setting by the use of the air-proof lining, or to some other cause, his experiments were not carried far enough to determine. However, whatever the cause, an improvement was effected.

R. O. Richards.

Framingham, Mass.

Injector or Pump Most Economical Boiler Feeder?

The assertion is sometimes made that an injector is the most economical boiler feeder, and, on the other hand, some say that a pump and heater is the most economical. I have never seen any figures given to prove either statement. I have made a comparison of the two in a plant where the conditions from day to day are as nearly uniform as can be found in a manufacturing plant.

We have two sets of boilers—twelve running for power and four for heating. Each set has a steam pump and a heater and each boiler has an injector. The steam available for the heaters is the exhaust from two air compressors, and two pumps. The heaters condense all of the exhaust steam, so that no steam comes from the exhaust pipes.

With both pumps and heaters working, and with winter temperatures the feed water entering both systems is from 50 to 75 deg. F. By feeding the four heating boilers with the injector and passing all the exhaust steam through the large heaters, feeding the 12 power boilers with the pump, the feed water in both systems rises to 150 deg. Again, by feeding the four heating boilers with the pump and heater, and the power boilers with the injector, passing the water from the injector through the heater we get a feed-water temperature of 180 deg. in both systems.

We can, therefore, compare the coal consumption under both conditions. I have done this on alternate days for two weeks, and, without exception, on the days when the injectors were used, the coal burned in the power boilers was over a ton less than on the days the pump was used, all other conditions of load, etc., being the same. I might add that the injector we have is a high-grade locomotive type that can be reduced 60 per cent. of its capacity, and it is not stopped from 7 a.m. to 6 p.m.

W. E. Hopkins.

Torrington, Conn.

[It should be noted that the amount of exhaust steam available for the feed-water heater is small in this plant. —Editor.]

Gases in Furnace Explode

An incident which I witnessed recently serves to show the need of caution in furnace operation.

The steam pressure having risen to the point of blowing off, the fireman unhooked the damper chains from the regulator, closing the damper tightly. This was the course usually pursued when the boilers were left for the night. As we were blowing down the boilers the fireman proceeded to blow down the water columns, which were piped so as to discharge into the ashpits. He had just finished when I called him to me some ten feet to one side of the furnace doors to tell him of the probabilities of a furnace explosion with conditions as they then prevailed.

The words were hardly uttered when an explosion occurred. The furnace, ashpit and combustion-chamber doors were blown open, allowing fire, smoke, gas, etc., to be blown into the room. It was well for the fireman that he stepped to one side at the moment he did as he could hardly have escaped being badly burned. The supposition is that the proportions of carbon monoxide and air happened to be just right to make an explosive mixture, and being bottled up by the tightly closed dampers, an explosion occurred. The settings were not wrecked, but, no doubt, the relief afforded by the various doors was all that saved them. It would seem that it is unsafe to pipe up blowoff lines from water columns, etc., to the ashpits. When they are piped in this way the columns should never be blown down when the dampers are closed tightly.

Edward T. Binns.

Philadelphia, Penn.

[We wish to emphasize the writer's last sentence, for it is hardly to be recommended that the column blowoff be piped elsewhere than to the ashpit. The practice above warned against should be avoided under any conditions but particularly when fresh coal has just been thrown on a hot fire.—Editor.]

QUESTIONS BEFORE THE HOUSE

Slippage of Reciprocating Pumps

Some interesting facts were given by Mervin K. Baer in the article on "The Slippage of Reciprocating Pumps." As this is a question of great moment to all engineers, some actual figures from his tests are appreciated. The writer hopes he will go further into the problem and collect more data, so that he may give a workable formula to use in practice.

The writer has used a formula for pump slippage, which gives results very different from the actual tests recorded in this recent article, but in view of this information he has now abandoned it, and is using an entirely new formula based on Fig. 2 in Mr. Baer's article. This is:

$$x = \frac{\sqrt{P} \times 2000 \times G}{S \times L}$$

in which

x = Percentage of slip;
P = Pounds pressure of the liquid;
G = Specific gravity of the liquid;
S = Piston speed in feet per minute;
L = Length of stroke in inches.

That the valve slip varies inversely as the stroke can hardly be denied, as it is obvious that with the same diameter of barrel and valves, the slip is in proportion to the number of reversals of the valves, and this number is twice as great in a pump of half the stroke, when both pumps have the same piston speed.

When water is being pumped, G need not be considered. The slip is undoubtedly increased with the viscosity of heavy liquids. In sugar-house work we have to pump liquids of densities from that of water to molasses which will weigh 12 lb. per gal. with a density of about 90 deg. Brix. Special pumps are used for this work, but even then it is difficult to force the molasses into the barrel. The valves tend to stick open and they lose their relative weight, so that it is safe to assume the slippage increases in close relation to the specific gravity.

How the factor of specific gravity will work out with oils the writer does not know, having had no experience in pumping liquids lighter than water; but for heavier solutions free from foreign matters, it checks up well with practical work.

The formula is suggested for use within the usual limits of pumping practice as a guide to the slippage to be expected, and an aid in selecting the displacement of the pump required. No formula can give the actual slippage that will be experienced, as this depends on so many things. An outline of the factors controlling the slippage in the valves follows: The length of the pump stroke, pressure pumped against, piston speed, condition of the valve seats, tension of the springs or weight of the valve, height of suction lift, viscosity of the liquid, lift of the valves, shape of the valves and their chamber.

The writer is inclined to the belief that there is more valve slip in direct-acting pumps than there is in flywheel pumps; as the crank pumps do not have the "get away" action of the direct-acting, allowing relatively more time to the valves to "nest home."

The liquid pressure, piston speed and the condition of the valves have been touched on by Mr. Baer. The proper tension on the valve springs has a lot to do with the proper working of the pump, and strictly speaking they should be adjusted and set differently for every condition of service. The higher the pressure pumped against the tighter the springs can be, and the less the suction lift the tighter the suction-valve springs can be. It is an advantage to have the springs as tight as possible for the particular pressure, as the slip is reduced. The nearer the suction water to the pump, naturally the less reduction of pressure in the pump chamber, with consequent reduction of slip in both valves and piston.

The lift of the valves and their general setting should be mentioned. The old-fashioned large valves with the necessary high lift are very little used now, as it is recognized that more valves with low lifts allow far less slippage, and are therefore more economical. The setting and shape of the valves can also affect the slip, as the time of closing will be partly controlled by the way the rush of liquid strikes the valve proper, whether a return rush will aid prompt closing, or by striking it on the side actually tend to retard the closing.

An examination of the formula will give an idea of the relation of the various factors. It may be seen that it is an advantage to have long strokes and high piston speeds with low pressures and specific gravities.

The rise in the curves when the piston speed exceeds a certain amount is not explained by Mr. Baer. He may have data that will throw more light on this point. One explanation is that the rise is due to the choking effect of the suction valves, and so would vary with every pump. There is a certain limit to the velocity at which the water can be forced into the pump by atmospheric pressure, and it is probable that the phenomenon of cavitation causes the increase of slip beyond a certain speed.

Havana, Cuba. CHARLES E. NEWBOLD.

In the Apr. 8 issue of POWER, I was interested in an article on slippage, by Marvin K. Baer, particularly as it refers to a test of pump No. 7 of the Milwaukee waterworks, made in June, 1911, which showed a slip of 43 per cent. After repairs were made to the valves the slip was reduced to 9 per cent.

Insofar as there are no reliable data obtainable on the slippage of reciprocating pumps, I agree with the author's statement, but do not believe that the operating engineers have been indifferent or that they have not made experiments of a practical nature along this line.

In modern pumping stations supplying large cities, the pumping engines are usually of the outside-packed plunger type and if the suction lift is not excessive and the machine properly designed, the main source of slippage would be through the pump valves. I believe from long experience that the average slippage throughout the

year can be kept within a range of from 2 to 5 per cent. for this class of pumping machinery.

Mr. Baer cites a number of tests made on a variety of pumps and gives the slippage, but does not state the instrument used to determine the slippage. The test on pump No. 7 in 1911 was made with a pitometer which was first inserted in the delivery main about 16 ft. from a right-angle curve within the building and at certain portions in the diameter of the pipe showed a minus flow. Another insertion was made just outside the building, which was also found unsatisfactory. Still another insertion was made about 500 ft. distant from the pump. This test was reported to be satisfactory and showed a slippage of 43 per cent. It may also be noted that this pump was not in service when the test referred to was made, but was laid off for the renewal of valves; a leakage was known to exist and reported before the test was ordered. The cause of the leakage was sand getting under the rubber disks, probably coming from a connection previously made to the intake tunnel. Notwithstanding the large slippage reported, this pump, running alone, in taking care of the night demand (which is always uniform) for the high district showed a loss of only 15 per cent. compared with No. 8, a duplicate pump which at the test showed less than 1 per cent. slip.

By men who have made a study of the pitometer, it is usually conceded that when applied to a straight line of pipe of uniform diameter and manipulated with care, the flow may be determined within 2 per cent. Where it is placed near curves or an enlargement or decrease in the diameter of the pipe, the results are not reliable. A certain pipe may be rated at 12, 20 or 30 in. in diameter, but none are absolutely of the required dimensions, depending on the core maker and the manner of pouring the metal in the foundry.

The most reliable method we have found so far to determine the leakage in an outside-packed plunger pump in everyday practice is to put the full water pressure over the suction or delivery valve-deck when the pump is standing idle and examine the leakage of the valves underneath. By this means a practical operating engineer can determine with sufficient accuracy the condition of the valves, as they are liable to leak more under a static head than when in regular operation.

The present administration in Milwaukee has now a practical survey branch of the water service conducted by practical men, which makes a thorough examination of all unmetered services and is beginning to show good results by increasing the revenue. Notwithstanding the large percentage of slip reported, the gallons per capita have been gradually increased from year to year.

1910	gal. per day to population supplied (plunger displacement)	109.0
1911	gal. per day to population supplied (plunger displacement)	111.9
1912	gal. per day to population supplied (plunger displacement)	113.2

This gradual increase has been the experience of nearly all large cities and is due to the extension of large manufacturing industries and not to indifferent operation or pump slippage at the pumping stations. With Mr. Baer, I believe that no hard-and-fast rule can be laid down to determine the slippage of a pump, as the conditions may change in a day or an hour by the displacement or breakage of a valve, and it is not always convenient to shut down even if a leak is apparent. In the Milwaukee waterworks the water delivered is figured slightly below the measured displacement of the pumps, but in making the annual statement the superintendent, in accounting for water, allows 5 per cent. for slippage of pumps. The following is the statement for the year 1912:

	Per cent.
Metered consumption	65.71
Unmetered consumption	9.02
Underregistration of meters	3.00
Slippage of pumps (assumed)	5.00
Water unaccounted for	17.27
	100.00

The unaccounted-for water includes unavoidable leakages in the reservoir, water used for settling trenches in laying 15 miles of water mains and water used for settling about 2000 plumbers' trenches and fire cisterns, all free. The balance is credited to leakage in the distributing system, consisting of 495 miles of water mains from 4 to 42 in. in diameter. It may be seen from the above data that the pump slippage is well within 5 per cent. throughout the year.

THOMAS MCMILLAN,
Milwaukee, Wis., Chief Engineer Pumping Stations.

Safeguarding Economizers

In the issue of Feb. 4, is an interesting editorial entitled, "Why Do Economizers Explode?" The writer having come in contact and examined a great many economizers, thinks a better title would have been, "Why Don't More Economizers Explode?"

It has been my privilege to examine economizers that have been in service for over 30 years and others that were practically new. Many of them were not doing anywhere near their capacity in work, due principally to neglect. It appears to be the general rule in some boiler houses to treat an economizer as though it were merely a feed-water heater instead of practically being a water-tube boiler. I have noted gases entering the economizer chamber at considerably over 600-deg. temperature.

Some economizers are seldom examined or cleaned externally until the soot has banked up around the tubes. Naturally the draft is retarded and an investigation is then made. This neglect is doubtless because the work of cleaning out is so disagreeable and dirty. One way to avoid frequent soot troubles is to go on top of the economizer each day and see that the scrapers are working. If they are not it is only a few minutes' work to release and operate them by hand until they work freely. This has nothing to do with explosions, but it makes it easier to note any defects when an external inspection is made.

An economizer should be thoroughly cleaned out and examined inside once a year and attention given the safety valve at all times. I think there should be two safety valves on each economizer, because the feed water enters it from a heater and as the flue gases pass through the chamber at high temperature there will generally be a larger quantity of scale deposited at the discharge end of the economizer. I have found safety valves partly choked with scale. If there were a second safety valve on the feed-water inlet end it would be quite sure to work because very little scale accumulates at this point. These valves should be tried daily.

The damper nearest the stack should never be tight. An inch play would always allow gases to escape from the economizer when out of service, but the damper nearest the boilers should always be tight. Such a damper

is often made of thin sheet iron, and the hot gases have a tendency to warp it. The same might be said of the flue at the entering end. It is quite common to find that the damper will not close properly because the flue is bulged in at the center. A remedy for this would be to have light iron flues braced on the outside with angle or tee iron near the damper.

Very rarely does an economizer explode while in operation. In any event it would not prove disastrous. If one or more of the tubes begin leaking the water will run into the soot pit where it is readily noticed, if the economizer is located overhead. If the soot pit is below the boiler-house floor, and the leakage cannot be noticed, the fireman can easily tell something is wrong, as the soot becomes damp and will not fall into the soot pit. Instead, it will bake on the tubes and choke the draft.

One of the greatest dangers of an explosion is when an economizer has been laid off and is about to be put back in operation. Then the greatest care should be taken to see that the tubes and headers are cool before filling them with water. After noting that the economizer is full, by opening the vent valve on top, the stack damper should be opened and, lastly, the main damper opened to the economizer chamber.

In summing up, to avoid trouble, first keep the economizers clean; secondly, make frequent examinations and above all see that the safety valves are in good working order.

GEORGE H. HANDLEY.

Newburgh, N. Y.

If the high-temperature feed water did not flash into steam.

If the leakage of gas past the dampers when the economizer is out of service did not occur.

If excessive pressure did not build up in the feed pipe and in the economizer proper.

If scale did not form in the headers and tubes, causing them to become overheated and weakened.

If excessive strains resulting from unequal expansion and contraction did not occur.

Then there would be no economizer explosions.

This is a flat statement to make, nevertheless, I think those familiar with economizer engineering will agree with the writer. Economizer failures can generally be traced directly to one of the five basic "ifs." It should be remembered that the same principle applies to the operation of economizers as to that of steam boilers, and they require the same care and attention. The tubes and surface must be kept clean, inside and out, and when closed down for repairs should be given a rigid inspection. Because of the comparatively high temperature of the feed water, considerable scale-forming matter is precipitated and can be blown off at the economizer. For this reason every economizer should have a mud drum and proper blowoff connection. There should also be a water-pressure gage in the boiler feed-water line, on the economizer side, with a water-relief valve on the economizer to guard against excessive pressure. A feed-pipe pressure of 200 lb. is commonly sufficient. Any sudden rise in the economizer pressure would be quickly detected by the fireman by merely glancing at the gage.

Careful records should be kept of the flue-gas temperature on entering and leaving the economizers. Very high flue-gas temperatures should be avoided. Many plants are producing excellent results with gas entering the economizers at considerably less than 500 deg. I consider a temperature of 260 deg. in the feed water going to the boilers from the economizers as sufficient. In many plants, however, the feed water enters the economizers at 210 deg. and leaves at 270 or 275 deg., and this is considered well within the limits of ordinary operation.

I have operated several large economizer installations and I must admit a disposition to be cautious prompted me to always closely observe the details of their operation. I am convinced that at extremely high temperature the feed water should be handled with care, as the large heat and water-storage capacity of the economizer is a factor to be seriously considered.

Many engineers consider water-tube boilers and economizers immune from serious explosions. This is a fallacy. However, with the exercise of proper care and skill on the part of those in charge of economizers, together with periodical and rigid inspection by experts during construction and operation, economizer explosions should be rare.

Marietta, Ohio. W. M. ALEXANDRE.

In an installation of economizers, with which I am familiar, provision has been made to eliminate, so far as possible, the dangers of an explosion, due to an excessive pressure. The economizers are outside of the boiler house and across the smoke flue leading from the boiler house to the chimney, and are under boiler pressure. The feed water is supplied by an electrically driven triplex power pump.

This pump runs with a variable speed and is under the control of a boiler-house attendant. As one of the three plungers is always on the discharge stroke, there is a steady flow of water, which eliminates shocks to the feed line and economizers.

A relief valve, in the feed line near the pump, prevents an over pressure. This valve is set to open at several pounds higher than the blowing-off pressure of the boilers. Each economizer has a spring-loaded safety valve, so that with the relief valve in the feed lines the danger from excessive pressure should be practically eliminated.

However, the best safety device becomes useless if neglected. The safety valves on the economizers should receive the same as, if not more, care than the safety valves on the boilers, because they are more likely to stick, due to impurities in the water.

The disk should be raised from its seat daily. This is not always done. Sometimes, where economizers have been cut out of service for cleaning, it has been found that the passage leading to the valve, and also the tubes and valve, were covered with a soft scale. If the valve is not opened the scale will accumulate until the valve refuses to operate.

It does not seem to be generally known that an economizer is also a good water purifier. The bad feature is the cleaning, as it is a long, tedious job to remove the scale from the many tubes. Water containing sulphate and carbonate of lime will precipitate impurities when heated to a temperature of 212 deg. F., and as the temperature of the feed water is much higher these impurities are held in suspension, but will gradually settle on the tubes and headers.

EDWIN C. MILLER.

Cleveland, Ohio.

INQUIRIES OF GENERAL INTEREST

Kinds of Direct-Current Generators—Into how many classes may direct-current generators be divided according to the methods used for exciting their fields?

E. H. I.

Three—series wound, shunt wound, and compound wound.

Removing Pump Piston—How should the piston of a duplex pump be removed from the rod if a lead hammer will not effect it?

F. S. H.

The piston and rod should be stood up vertically and the joints liberally moistened with kerosene for several hours. Then if the rod cannot be driven out with a lead hammer a countersunk driver should be used over the end of the rod and more powerful blows struck with a sledge. When using a countersunk driver the nuts on the piston rods should be run out to the end of the screw to protect the thread.

Increase of Horsepower—An engine develops 100 hp. when running at 75 r.p.m. with a mean effective pressure of 40 lb. If the mean effective pressure is increased to 45 lb. and the speed to 80 r.p.m., what will be the power developed?

E. H. Q.

The power developed per revolution per minute and per pound of mean effective pressure is

$$\frac{100}{40 \times 75} = \frac{1}{30} \text{ hp.}$$

Then at 80 r.p.m. and 45 lb. pressure it will be

$$\frac{1}{30} \times 80 \times 45 = 120 \text{ hp.}$$

Inserting Boiler Tube—What precautions are necessary when putting a tube in the bottom of a B. & W. boiler?

F. S. H.

Particular care should be taken not to injure the hanging baffle walls or main bridge wall. In expanding the ends of the tubes, especially the rear end, care should be taken to have the tube holes kept dry and clear of all dirt and sediment, so that there may be no leaks at the lower ends when expanded into the header at points not readily inspected while the boiler is in use. In cutting out the old tube and expanding the new tube, the same general precautions should be taken not to injure the tube hole in the header, as always should be done in setting any of the tubes of such a boiler.

Compressor Horsepower—What horsepower is required for a compressor having a bore of 12 in. and a 24-in. stroke, making 72 r.p.m. and delivering against a pressure of 180 lb.?

J. O. B.

The horsepower per 100 cu.ft. of free air compressed per minute may be found from the formula

$$Hp = 1.511\ P_1\ (R^{0.29} - 1)$$

where

P_1 = Pressure of free air, pounds absolute;

R = Ratio of pressures $= \frac{P_2}{P_1}$

where

P_2 = Pressure of delivered air, pounds absolute.

Substituting in this formula

$$\text{Hp.} = 1.511 \times 14.7 \left[\left(\frac{194.7}{14.7} \right)^{0.29} - 1 \right] = 24.775 \text{ hp.}$$

per 100 cu.ft. of free air per min.

From the dimensions given the quantity of free air compressed per minute would be

$$\frac{(12 \times 12 \times 0.7854) \times 21}{1728} \times 74 \times 2 = 203.426$$

cu.ft. per min., requiring

$$\frac{203.426}{100} \times 24.775 = 50.4 \text{ net hp.}$$

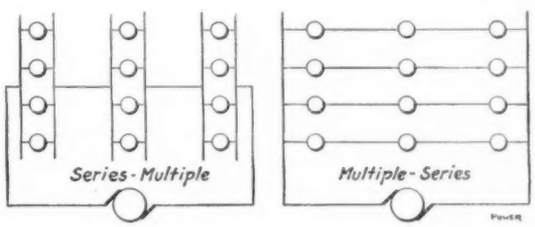
The indicated horsepower required to be developed by the steam end of the compressor would depend on its mechanical efficiency. This for average working conditions would be about 85 per cent., so that the power developed by the steam end would be about

$$\frac{50.4 \times 100}{85} = 59.3 \text{ i.hp.}$$

Combination Electric Circuits—What is the difference between series-multiple and multiple-series as applied to lighting circuits?

E. R. M.

The difference in the wiring is shown in the diagram where in each case the 12 lamps involved are in the same relative positions the better to emphasize the difference in their connections. With all lamps burning the effect is the same with either system of wiring, but in the multiple-series connection the extinguishing of one lamp extinguishes the rest in that series (i.e., in this case the same horizontal line), whereas putting out one light in the series-multiple connection does not put out any others. It does, however, make the other lamps in parallel with it (i.e., the same vertical line in the diagram, burn more brilliantly and the rest less brilliantly. The reason is that the combined current which passes through four lamps in parallel must go through three lamps in the circuit where one has been extinguished, and, conversely,



only the current which can get through the three lamps is available for the four-lamp groups. If all but one or two lamps should be extinguished the remaining lamp or lamps would be likely to burn out. For this reason this system of connections should generally be avoided unless conditions are such that excess current through any lamps is unlikely.

Water-Power Calculation—What horsepower will a stream of water deliver, entering an 8-in. pipe 2 in. below the level of a lake, with a head of 20 ft., using a common low-pressure turbine?

E. R. F.

The most water that could get into the pipe would be that due to a head of 6 in. (lake surface to center of pipe) entering an aperture 8 in. in diameter, for if the head of 20 ft. in the pipe, by suction, tended to draw the water in faster, the surface of the water immediately over the pipe would cavitate and air would be drawn into the pipe.

The velocity of flow in feet per second is expressed by the formula

$$V = \sqrt{2gh}$$

in which

$2g = 64.4$

h = Head in feet $= \frac{6}{12} = 0.5$ ft.

Then

$$V = \sqrt{64.4 \times 0.5} = 5.67 \text{ ft. per sec.}$$

The cross-sectional area of an 8-in. pipe is 50.265 sq.in. or 0 349 sq.ft.

Based on experiments with a variety of weirs and apertures, the coefficient of discharge may be assumed to be 62 per cent. for the conditions in this case. Then the water passed by the pipe would be

$$5.67 \times 0.349 \times 0.62 = 1.2269 \text{ cu.ft. per sec.}$$

or

$$1.2269 \times 62.355 = 76.5033 \text{ lb. per sec.}$$

or

$$76.5033 \times 60 = 4590.198 \text{ lb. per min.}$$

With a head of 20 ft. this would develop

$$4590.198 \times 20 = 91803.96 \text{ ft.lb. per min.}$$

or

$$\frac{91803.96}{33{,}000} = 2.78 \text{ hp.}$$

As ordinary good lowhead turbines have an efficiency of 75 per cent. the actual or brake horsepower realized would be

$$2.78 \times 0.75 = 2.09 \text{ b.hp.}$$

ENGINEERS' STUDY COURSE

Analysis of Coal—III

Making the Analysis

You have now been introduced to all the apparatus needed in making a proximate analysis and all that remains to be acquired is a little practice in handling the equipment and running the actual analysis. Run five or six analyses just for the practice.

From the outset, remember that the more careful and painstaking you are with the work, the more accurate and reliable will be the results. The sample dealt with, one gram, and the differences to be determined in the weight of that sample after each step, are so small that it requires but a slight inaccuracy to throw out the entire work.

Get into the habit of following exactly the same process with each analysis. Do not use one method one day and then vary it, even slightly, the next. Decide by experiment in the beginning the best method for you to follow and stick as closely to that method as possible with all your analyses. The object of this advice is to insure uniformity in results. If you use one method one day and a slightly different method the next, the results are not likely to be uniform. And what you want is a fair comparison, one day with another.

A good method to follow is this: Assume that a 5-lb. sample of the coal to be tested has been collected as described in Part I. Rule off a form on which to record the analysis. The one shown, already filled out, in Fig. 9 is convenient but may need slight modifications to suit special needs. If you expect to analyze coal regularly, it will pay to have the form printed or mimeographed.

First, see that the crucible is thoroughly clean and dry. Then weigh it, together with its cover, as accurately as possible, remembering to test the balance first. Weigh the crucible and cover before every analysis, to be sure that the weight is accurate, for if a slight chip should break off from either, the results would be wrong unless the new weight of the crucible were used. Enter the weight in the proper space on the report sheet. Then, fill out the first space by adding one gram to the weight of crucible and lid.

When weighing it is not necessary to wait for the balance to come to rest each time; simply notice whether the pointer swings uniformly a given number of divisions each side of the center line on the scale. But be sure that the swing is exactly uniform. Leave the crucible in the scale pan ready to receive the sample.

Spread out the 5-lb. sample on a clean surface (such as a piece of newspaper) mix thoroughly and quarter down to about one pound. Put this quantity through the coffee mill once or twice, grinding as fine as possible with the mill. Again mix and spread out thin on a clean surface. Then, with a knife blade, select small quantities from a half dozen places in the mass and put them in the mortar, thus obtaining about one ounce. Crush thoroughly with the pestle. Sift this finely crushed sample through the 100-mesh sieve into the tray that comes with the latter. If any of the sample will not pass through, put it back into the mortar and crush until practically all passes through.

If you are working without a sieve be sure that the sample is crushed fine enough. It should look like a very fine dust—so fine and uniform that no individual particles are distinguishable.

Now, add one gram to the weights in the balance and put enough of the powdered sample into the crucible to again restore equilibrium.

Put the crucible (without cover) into the oven and heat to 110 deg. C. for one hour. Keep heat as uniform as possible. Now, quickly transfer the crucible to the desiccator and allow it to cool off. This will take about 10 min. When cool, weigh crucible (with lid) and enter weight in the second space on the report sheet. Subtract this weight from the one above, move the decimal point two places to the right and enter result as percentage of moisture in the proper space.

Next, place the crucible, with lid on and in an unright position, on the triangle and ringstand over the burner, as shown at the left in Fig. 2. Turn the flame up strong and heat the crucible for full 7 min. The flame should be long enough and placed close enough to the crucible to completely envelop it and shoot above for a distance of an inch or more.

At the end of the 7 min. remove the flame and transfer the crucible and lid to the desiccator to cool. Inspect the sides of the crucible to make sure that the porcelain insulators on the triangles have not softened under the heat and left small particles sticking to the former. If this occurs the analysis will have to be done over, as the weighing would be inaccurate. If this occurs frequently, a "Nichrome" wire triangle will have to be used instead of the porcelain insulated one. The cost of one of this kind is about 35c., but it is durable and will not stick.

In heating to drive off the volatile matter a black smudge of carbon will probably be made on the outside of the crucible. Most people burn this off before transferring to the desiccator by playing the flame on the sides. I am not going to advise you to do this because unless carefully done, it leads to the breakage of crucible or lid, thus spoiling an analysis. Besides, the error caused is so *very* slight that it is hardly worth the trouble taken to eliminate it, and, if the same practice is followed each time, the importance of the error is still more reduced. However, before another analysis is made in the crucible both it and the lid should be cleaned by carefully burning off this carbon deposit.

When the crucible is cool, weigh and enter the weight as before. The loss in weight this time represents the percentage of volatile matter contained in the coal.

Next, place the crucible, without cover, on the stand again, only this time, tilt it as far on its side as you can without danger of any of the contents being spilled or blown out. Turn the flame on strong, as before, and heat thus for at least two hours. See that the flame concentrates under that part where the sample lies.

At the end of the heating, cool in the desiccator and weigh again with the lid. The loss in weight this time represents the percentage of fixed carbon. And, the difference between this last weight and the weight of the empty crucible with lid represents the percentage of ash in the coal.

The analysis is now finished and all that remains is to stow the apparatus safely away until next needed and to calculate the analysis of the dry coal.

The analysis which we have just completed is that of the coal "as received." Strictly speaking, it is not the true analysis of the coal as received because some of the moisture dried out while the sample was being prepared for testing. But, as long as about the same length of time is taken up in preparing the sample in each case and as long as the process of treatment is the same, the error remains about the same and, so, we may call it the "as received" analysis and do no particular harm.

With some grades of coal which have a great capacity

PROXIMATE ANALYSIS OF COAL

Plant. Progress Mfg. Co.

Car Nos. C. R. I. 74931, M. & R. 14865. Total Tons in Shipment. 80

Date Received Jan. 9, '13. Date Sample Taken Jan. 9, '13. Date Analyzed Jan. 10, '13

Analyzed by Garnet Ornate

	Grams		Analysis of Coal as Received	Analysis of Dry Coal
Wt. of crucible and lid plus sample	21.522			
Wt. less moisture	21.445	Per cent. moisture	7.7	
Wt. less volatile matter	21.167	Per cent. vol. matter	27.8	30.12
Wt. less fixed carbon	20.637	Per cent. fixed carbon	53.0	57.42
Wt. of empty crucible with lid	20.522	Per cent. ash	11.5	12.46

Heat value of dry coal (by calorimeter) ..... B.t.u. per lb. Cost of Coal, $ 2.90 per ton

Heat value of combustible (estimated) 15,975 B.t.u. per lb. No. B.t.u. purchased for 1 cent 85,670

Heat value of dry coal (estimated) 13,459 B.t.u. per lb.

Heat value of coal as received (estimated) 12,423 B.t.u. per lb.

FIG. 7. PROXIMATE ANALYSIS REPORT FORM

for absorbing moisture it is necessary to air dry the sample before it can be passed through the sieve. In such cases if extreme accuracy is important, a preliminary air-drying test must be made and the moisture thus eliminated must be included in the calculations. But as this complicates matters somewhat, I do not recommend that it be attempted in ordinary work. If the coal will not sift through the sieve readily when first crushed, it may be allowed to stand exposed to the air for one-half to one hour. A better method to employ, because it insures more uniform analyses, is to coarse grind a sample of a pound or two in the coffee mill, spread it out in a thin layer and leave it exposed to the air at 70 to 80 deg. F. for 24 hours. If this method is adopted regularly, the term "air dried" should be substituted for "as received" throughout the report form in Fig. 7.

To figure the analysis of the dry coal from the analysis of the "as received" sample, simply divide the percentage of volatile matter, fixed carbon and ash (each in turn) by the sum of all three. Thus, taking the analysis given in Fig. 7, the sum of the percentages of volatile matter, fixed carbon, and ash is,

$$27.8 + 53 + 11.5 = 92.3$$

This sum divided into the percentage of volatile matter gives

$$\frac{27.8}{92.3} = 30.12$$

as the percentage of volatile matter in the dry coal.

The reason is simple. Let us assume 100 lb. of coal of the analysis given. As the analysis shows 7.7 per cent. moisture, 7.7 lb. is water, leaving only 92.3 lb. when the coal is thoroughly dry. The analysis also shows 27.8 lb. volatile matter in every 100 lb. of the coal as received. Then, what fraction of the dry coal is the volatile matter?

$$\frac{27.8}{92.3} = 0.3012 \textit{ or } 30.12 \textit{ per cent.}$$

In a like manner, the percentages of the other two constituents, fixed carbon and ash, are figured.

Lighting the Panama-Pacific Exposition

The Panama-Pacific International Exposition is scheduled to open Feb. 20 and continue until Dec. 4, 1915, while the Panama Canal, which it commemorates, will be officially opened in full running order by the Government on Jan. 1 of that year.

As the canal will afford a new trade route for the commerce of the Eastern and Western Hemispheres, the question of devising a scheme of decoration and illumination that would not only distinguish the exposition as unique among its kind, but also typify in a measure the conditions of both the Orient and the Occident, seemed of utmost importance. W. D'Arcy Ryan, director of the illuminating laboratory of the General Electric Co., was appointed to undertake the commission. Something new in lighting was the general request, and it is Mr. Ryan's intention not to use a single piece of lighting that has ever been used before. There will be no dazzling white exposition or outlining of buildings with incandescent lamps. It is the intention to make the exposition a city rich with color. The ground tones will be about the color of travertine stone, intensified by lighting to an ivory yellow, which will appear almost white from a distance. Distinctive tones, so regular that they will blend in varied harmonies, Pompian red, strong Italian blues, vermilion and orange tones will be employed in the special color scheme.

The exposition grounds contain 625 acres in the harbor-view section, forming a natural amphitheater overlooking San Francisco Bay. In composition the architectural plan consists of three principal elements, that of the center being the main group of exhibit palaces and the other two elements balancing on either side. To the east lie the amusement concessions, while to the west lies the small city of foreign government pavilions and state buildings. The main exposition palaces occupy over 100 acres, covering an area over 4000 ft. long by 1200 ft. wide. The central block is divided by three magnificent courts developed longitudinally north and south. They are called the Festival Court, or the Court of Abundance, the Grand Court of Honor, or the Court of the Sun and Stars, and the Court of the Four Seasons. The Court of the Sun and Stars will stand out as a brilliant architectural expression distinguished by the majestic scale of its architecture and the splendor of its color

effect. The tower at the southern entrance will be studded with 50,000 jewels, diamonds, topazes, rubies and sapphires, which will sparkle at night in the rays from batteries of searchlights. Jewels will also be used wherever they can add to the beauty of an architectural line or surface or sculptured form. They will be suspended upon delicate springs, so that the least vibration from the wind or machinery or even the tramping of feet may keep them in constant motion and set them flashing.

In the court will be two immense fountains, one signifying the spirit of the East, and the other the spirit of the West, brought together through the Panama Canal. At night the court will be illuminated from the fountains. They will be constructed of dense white glass, and within each will be concealed 72 luminous arc lamps. When the arcs are lighted the entire surface of the fountain will become luminous, flooding the court with a softly diffused white light.

In the courts there will be various great mural paintings, which will be illuminated by concealed lamps set into the pillars fronting them, a special tubular lamp having been perfected for the fluted columns. The lamps and reflectors are made small enough to insert into the flute, and on smooth columns three lamps will be inserted at heights of about 10, 20 and 30 ft., and partially concealed by reflectors. The illumination on the paintings will be controlled in intensity by changing the size of the units and the curvature of the reflecting surfaces. By introducing colored bulbs any color effect may be obtained.

Throughout the grounds ornamental luminous arcs will be used and fitted with dense globes, so that it will be possible to look at them directly without injury to the eye. Inclosed-flame arc-lamps will be used extensively for indoor lighting.

There will be electric fountains, but no water will be used; instead, smoke and steam will be sent into the air, and will glow from the rays of the scintillator. A locomotive mounted on a steel turntable will supply the smoke and steam. If experiments now being made prove successful, thousands of large soap bubbles will be released from a large blower and float into the air to pass through the rays from the searchlights. Quantities of cloth balls will also be sent up into the air and will glow with ever-changing color combinations in the projected beams of colored light.

The large electric scintillator, which will be anchored on barges in the bay 500 yards from the shore, will consist of a battery of 48 searchlights aggregating over four billion candlepower and have 36-in. parabolic mirrors. The lights represent the 48 states, and will require 60 men to operate them.

That the exposition in its entirety will leave a lasting impression of its greatness and grandeur on the many thousands of visitors, both from this country and abroad, is assured. It will be a fitting and adequate expression of the opening of the new great way to the East and the West. But the impression of newness that will charm and linger long with the visitor, will be the combined decorative and lighting scheme.

❖

The energetic fight being made for new business by the Quebec Railway, Light & Power Co. and the Dorchester Electric Co., of Quebec, is reflected in the reduction of rates made by the former company from 15c. to 7c. per kw.-hr. The Dorchester Electric Co. announces its intention of meeting the cut by making its base rate for energy 6c. per kw.-hr.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

"What becomes of the water?" asks a correspondent. Why, the hydro. people utilize a good-sized bunch of it; some of it is tucked away in boilers and dams; it's sometimes used for bathing purposes; some people have been known to drink it; and— Say, what are you trying to do, anyhow; kid us?

❖

Horace Darwin, the British aëronautic expert, says that "if the birds knew how, they would copy the Wright biplane." The birds know too much already, Hoddy. Wish you'd been with us to the band concert in the park last Sunday afternoon. We sat under one of those Longfellow spreading chestnut trees, and our new straw kelly with the green bow in the back was— On second thought, we agree with Hoddy that the birds ain't got the (W)right idee.

❖

"He lighted his pipe and then sat on his chest," contends a magazine-story writer. In our kid days we sneaked under the flap of the circus tent and witnessed some thrilling contortions, but we can't quite figure out this chest stunt.

❖

Glad to know that somebody can get away from old man Consequence. A correspondent in the "Engineering and Mining Journal" says that one of the qualifications of a consulting engineer is "a diabolical ingenuity in escaping consequences." Anyone step on your ingrowing toe nail, sonny?

❖

Bully publicity work is being done by the National Association of Building Owners and Managers. When it starts out to do anything, people hear about it and all about it. Some corking good papers are promised for the Cincinnati convention on office-building power-plant operation, smoke abatement, furnace operation, etc., written by "the man on the job." When you know something good, holler about it" is pretty near the size of their slogan.

❖

The scarcity of garbage cans in Hickman, Ky., prompted the local electric-light and ice company, when it bought new ice cans, to give the old ones to the city for garbage repositories. This is a very pretty sentiment coming from a central-station company. It might have sold them but no, Hickman "suffered considerably" for garbage cans, and (another touching sentiment), as the "Electrical World" says, the cans will "serve as a constant reminder of the desire of the company to coöperate wherever possible for the good of the community." You wouldn't think a garbage can could awaken such kindly sympathy and generous action!

❖

S. Kirlin's been curlin' up a few with a laugh in 'em. If you think they're a leetle out of focus, you've mistaken, for he's photographing for the Ioway trade, and you can't fool Ioway when it comes to pictures—or jokes. Read 'em!

Jimmy Maloney, th' little feller thet iles over to th' power house hit th' chief fer a day off one day last week; sed his grandma hed died an' he hed to help bury her.

Th' chief told him he'd let him off this time, but he'd noticed thet th' old lady hed a habit uv doin her dyin' act every year just before th' day uv th' openin' game on th' home grounds an' he wished Jimmy wud arrange with her to put it off 'till some other time, an' it might not be necessary fer him to hev to help bury her.

Old Hal Mossback's biler busted t'other day an' blowed Hal clean over th' hobble skirt factery an' he kum down straddle uv a telephone cable in front uv Hennessy's booze emporium.

Th' boss told him he reckoned he jist went in that direction 'cause he'd got used to doin' it.

Bill Grimes ast Hal how it felt to git blowed up. Hal sed he didn't notis anything unusual 'bout it; sed he'd bin stayin' down town late nights fer a spell an' th' old lady hed sorter got him used to it.

Sid Diggles ast th' Boss ef he cud git out uv th' ingin room fer a spell while he went to git married.

Th' boss hummed an' hawed fer a spell, an' then told him thet he cal'lated he cud do it this time, but not to let it happen too often.

Experiments on Efficient Boiler Operation

By B. W. Rogowski

SYNOPSIS—An account of the change made in a boiler plant to improve the efficiency. An analysis of flue gases showed a gain of from 6 per cent. to 11.8 per cent. CO_2.

More preventable losses were occurring in our boiler house than at any other part of the power plant. Experiments were conducted to determine such operating conditions as would reduce these losses. The steam-generating equipment consists of nine boilers, representing four types whose aggregate rated capacity is 2600 boiler horsepower. The reciprocating engines have a capacity of 2600 hp.

The processes of combustion were analyzed and it was determined that the heat losses attending the combustion of fuel were:

Loss in the dry chimney gases,
Loss due to incomplete combustion,
Loss of fuel through grates,
Moisture in the fuel and air,
Loss due to the presence of hydrogen in the fuel,
Unburned fuel in the form of soot or smoke
Radiation and other secondary losses.

The greatest loss is the heat carried away by the escaping chimney gases, part of which, usually, is preventable. The total loss in the dry chimney gases in best practice averages 25 per cent. of the total heat generated from the fuel; always, however, a loss of approximately 10 per cent. of the total heat value of the fuel is unavoidable and represents the cost of moving the gases. This loss was calculated as follows:

Assume the air supply to be theoretically correctly proportioned to the amount of coal burned, i.e., 11.5 lb. per pound of combustible; atmospheric temperature, 60 deg. F.; stack temperature at the base, 450 deg. F.; specific heat of the flue gases, 0.24. Then the heat carried away by the least possible weight of chimney gases with perfect combustion and the conditions specified above would be

$$(11.5 + 1) \times (450 - 60) \times 0.24 = 1170 \text{ } B.t.u.$$

With fuel having a calorific value of 12,500 B.t.u. per pound this means an unavoidable loss of

$$\frac{1170}{12{,}500} \times 100 = 9.36 \text{ } \textit{per cent.}$$

The remaining 15.69 per cent. loss is due to the excess air necessary for complete combustion. This represents from 50 to 100 per cent. excess air.

For any boiler installation the most economical percentage of excess air depends upon the size and nature of the fuel, the thickness of the fuel bed, the frequency of cleaning, the intensity of draft and the character of the grate. Although the loss in the best practice, due to excess air is 15 per cent. of the total heat content of the fuel, it often is as high as 40 per cent.

By determining the fuel value of ashes it was found that the loss of fuel through the grates was approximately 3 per cent. of the calorific value of the fuel. No. 1 buckwheat coal was burned on stationary grates of the herringbone type, with air spaces ⅜ in. wide. The presence of about 8 per cent. of moisture in the fuel is equivalent to a loss of 1 per cent. of the total heat value of the dry fuel for the average conditions of the plant.

The fuel loss through the grate bars and that due to the moisture in the coal were, however, regarded as inappreciable compared to other existing losses which were about to be attacked. We began by studying the operating conditions, leaving the correction of any appreciable losses due to fixed conditions for a later date.

We realized that economy in the boiler room depended largely on the choice of coal adaptable to the plant conditions and which would generate the greatest amount of heat at the lowest cost for handling and consumption. Also to provide operating conditions which would permit of the coal being burned with the highest commercial efficiency.

We were justified in using No. 1 buckwheat as our grates had a 25 per cent. air space, making them satisfactory for this small size of coal. The furnaces are wide and deep with a high ratio of grate area to the heating surface.

The stacks are 150 ft. high and the draft at the base is 1 in. of water. Auxiliary draft is provided by turbo-undergrate draft fans. The firemen are skilled and intelligent. The boiler load curves are such as require a coal consumption of approximately 17 lb. per square foot of grate area per hour.

Several furnaces had flexible air-cooled and self-supporting arches. Since No. 1 buckwheat is very low in volatile matter, 6 per cent., it requires relatively little surface air and the air inlets to the arch must be adjusted accordingly. Each boiler setting was tested for tightness, first by candle flame and then by burning very smoky fuel in the furnace, shutting off the damper and all ordinary connections of the furnace to the atmosphere, when the smoke issued from the crevices. Two boiler settings were found very leaky and, before making repairs, samples of the flue gas were taken and analyzed, resulting in 6 per cent. CO_2, 14.2 per cent. O_2 and 0.9 per cent. CO. The stack temperature at the base was 790 deg. F.

After resetting the boilers, the enormously high stack temperature was found to be caused by heavy deposits of soot. Soot blowers were installed on a 350-hp. hand-fired water-tube boiler, which was receiving attention, and the sample of flue gas taken gave an analysis of 11.8 per cent. CO_2, 8.8 per cent. O_2 and no CO. The temperature at the base of the stack was 525 deg. F.

These results show an enormous increase in the rate of heat transfer and consequently in boiler efficiency brought about by cleaning the tubes. Methods of firing were next investigated. The practice was to carry thin fires, fire frequently and to cover the entire fuel bed at one time. The furnaces have four firing doors.

Experiments with the thickness of the fuel bed were made, for it was evident that, having established the quality and size of fuel and the intensity of draft, there was a certain depth of fuel for each furnace which would give the most efficient results. After many experiments, over a long period, a 4½-in. bed was found most efficient, on herringbone grates with a draft at the base of the stack of 1 in. of water and that the fuel thickness corresponded to a coal consumption of 18 lb. of coal per square foot of grate surface per hour. The fuel bed was thickened, firings were ordered to occur less frequently

and the results indicated a further increase in economy, due to a good setting, clean heating surface and an efficient thickness of fuel bed.

Analysis of the flue gas still indicated a trace of CO. Desiring to make combustion more complete, alternate firing was tried, i.e., firing only one side of the double furnaces at a time; this gave the desired result. The incandescent bed on one side of the furnace appeared white or very faint yellow and the excess air was highly preheated in passing through it. The other side of the furnace contained the bed of green coal and this appeared blue when CO was being generated and burning.

The combination of this highly preheated air and carbon monoxide at the bridge-wall secured complete combustion. An abstract of the log indicates the effect upon flue-gas analysis and stack temperature of various conditions and devices introduced.

Flue Gas Analysis Per cent. of Volume CO_2	O_2	CO	Stack Temperature, Deg. F.	Remarks
6.0	14.2	0.9	790	Conditions when experiments were undertaken.
7.2	10.0	0.0	760	Clinker removed; fire cleaned excess air reduced by removal of ash.
12.00	4.0	0.0	625	Fuel bed thickened, damper ¼ open, both sides of furnace fired at once.
13.0	4.0	0.0	600	Tubes blown, same condition as above.
9.8	8.2	0.4	590	Just after covering both sides.
9.4	10.4	0.0	550	Air holes 6-4 in. dia. holes opened wide: tubes in clean condition.
10.0	7.5	0.0	500	Air holes normal sizes, ⅞ in. dia.
14.0	3.0	0.0	470	Air holes closed almost entirely, tubes just blown: thickened fuel bed.

Observations show, and the general conclusions are, that the most efficient method of firing double furnaces with anthracite coal is to fire each side separately and at alternate intervals. The method known as "spot firing" has been established as standard here. The frequency of cleaning depends upon the rapidity of combustion and upon the percentage of ash in the fuel. For the conditions outlined, two cleanings in ten hours have proved most satisfactory.

As anthracite coal tends to break up into fine fragments when burning, the fire must not be disturbed except when cleaning, or the percentage of unburned fuel in the ash will be excessive. The luminosity of the flame at the first bank of tubes may be regarded as a fair indicator of the proper thickness of fuel bed. A luminous flame is one in which incandescent carbon exists and its presence in the flame indicates too little air for good combustion; the fuel bed must be thinner, or a readjustment of the surface air will be necessary.

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It is perhaps not very well known that altitude has its effect upon machinery as well as upon the human being, particularly upon the efficiency of gas and oil engines, says *The Isolated Plant*. The atmosphere is so thin, comparatively, that a given compressing stroke of the piston of the gas engine results in much less compression and in this manner the engine loses in efficiency. Also the smaller amount of oxygen in the cylinder results in a smaller consumption of the residue in the oil engines.

An engine that in Chicago, St. Louis or New York had produced 75 hp. could do no better than 40 hp. in South America, where the altitude was 11,000 to 13,000 ft. above sea level. To obtain the 75 hp. it would require an engine of 110 hp.

The rarer atmosphere also makes necessary an essentially different construction in electrical devices.

American Society of Mechanical Engineers' Baltimore Meeting

Disappointingly small was the number in attendance, not quite three hundred, at the meeting of the American Society of Mechanical Engineers in Baltimore, Md., May 20 to 23. After the elaborate and painstaking preparations made by the local engineers to entertain the society it was regrettable more were not there. The approaching joint meeting in Germany with the Verein Deutscher Ingenieure kept many away from Baltimore for the party will sail June 10, only a little more than two weeks after the close of the Baltimore meeting.

The professional sessions were of considerable general interest, but only one of the papers was of much real moment to the power field—"Present Operation of Gas Engines Using Blast Furnace Gas as Fuel," by Charles C. Sampson of the Illinois Steel Co. A rather full abstract of this paper will appear in the Gas Power Department of the next issue.

The principal discussion was offered by Frederick C. Wagner, which referred especially to gas cleaning and described two successful cleaners used abroad, the Feld and the Schwartz cleaners. More concerning this discussion will be given in a later issue.

The meeting was opened Tuesday evening in the tea room of the Hotel Belvedere with an informal reception by the officers of the Engineers' Club of Baltimore. An address of welcome was made by the mayor, and response for the society, in the absence of President W. F. M. Goss, by Past-President Oberlin Smith. R. Keith Compton, president of the Engineers' Club of Baltimore, presided and a short account of the engineering history of Baltimore was given by Mendes Cohen, a veteran engineer of the city.

Wednesday

The business session convened Wednesday morning. Some time was spent discussing a proposed code of ethics for engineers and a good deal of difference of opinion was brought out; first, as to whether a need for one existed; second, if there was one, if it would be respected and followed by the profession; other points were taken up regarding individual clauses in the proposed code. So great were the differences of opinion regarding it that it was finally decided to submit the code to the entire membership by letter ballot and, when definite recommendations could be made, to submit a code to the Council for action—preferably adoption.

The desirability of adopting the myriawatt (10,000 watts) as a standard unit of power, first advanced by H. G. Stott and Haylett O'Neill last year, as noted in Power, Aug. 27, 1912, was defended by Mr. Stott against the criticisms offered by Willian Kent and George H. Barrus. Against the argument that introducing a new unit only added to the number in use and complicated rather than simplified matters, Mr. Stott indicated that the myriawatt is not a new unit but a little-used multiple of an old one that would be more convenient to use than horsepower and has the advantage that its value very closely coincides with one boiler horsepower. More concerning the discussion of the myriawatt will appear in a later issue.

In presenting his paper on a "Test of a Hydraulic

Buffer," Carl Schwartz used the lantern and showed views of the installation of hydraulic buffers for arresting trains in the Grand Central Station and curves plotted to show the pressure built up in the buffers in given elapsed periods when a train impacts on a buffer.

Edwin J. Prindle called attention to a matter of much concern to many, namely, the present danger of a modification of the patent laws that will divest the inventor of rights he now enjoys, and in the author's opinion, to which he is justly entitled. His paper outlined the cases which had brought up the matter of new legislation and showed the dangers in the anticipated enactments. It was urged that the society as a body and members individually communicate with congressmen and protest against the measures now in prospect of being adopted. A vote was passed that the Council be requested to forward such an official protest in the form of resolutions.

Theodore W. Johnson in his paper, "Shading in Mechanical Drawing," offered rules for making the practice standard.

"Cost of Upkeep of Horse-Drawn Vehicles Against Electric Vehicles," by W. R. Metz, brought out the most valuable kind of information in relation to trucking. Experience in the comparative costs of the two modes of transportation is the best guide to those contemplating a change of equipment. The author's conclusion was that motor-driven vehicles are unquestionably cheaper than horse-drawn vehicles where a number are used and that the only question is to decide between electric and gasoline trucks. Electric trucks seem to cost less to maintain, but gasoline trucks have a greater radius of action.

In the afternoon the city fire department gave a demonstration of the high-pressure fire system. Two motor wagons with three streams each were supplied with water from a single combination outlet under a pressure of between 250 and 300 lb. The pumping station was also inspected.

After this a sail around the harbor was taken on the municipal steamer, "F. C. Latrobe." While passing the fire boat "Deluge," the latter was put in action, throwing eight streams simultaneously.

A fascinating lecture, entitled "Around the World in Eighty Minutes," was delivered by the Hon. O. P. Austin, secretary of the National Geographic Society, in the evening. It was profusely illustrated mainly with moving pictures taken in all parts of the world.

Thursday

The entire session Thursday morning was given to the subject of Fire Protection, except for a recess while honorary membership was conferred upon Captain Charles H. Manning,* inventor of the Manning boiler, a retired engineer officer of the U. S. Navy, and until recently mechanical engineer of the Amoskeag Mfg. Co. In his response accepting the honor and expressing his appreciation, Captain Manning indulged in some reminiscences of his early engineering experience that were extremely interesting.

James B. Scott, with lantern slides, described "The Baltimore High-Pressure Fire Service;" F. M. Griswold presented the subject "National Standard Hose Couplings and Hydrant Fittings for Public Fire Service," calling attention to the present differences in diameters and threads used and how they could easily be harmonized. Albert Blauvelt discussed "Debarment of City Conflagrations," Ira H. Woolson, "Allowable Height and Area in Factory Buildings," (a summary of the result of a letter campaign among fire chiefs and fire marshals); C. H. Smith, "The Protection of Main Belt Drives with Fire Retardent Partitions," and H. F. J. Porter, "The Life Hazard in Crowded Buildings Due to Inadequate Exits."

The usual resolutions of thanks were passed to all concerned in the entertainment of the society and its guests.

The afternoon excursion Thursday was an inspection of the work on the new sewer system, including the Jones Falls conduits, the sewage pumping plant and the sewage-disposal plant at Back River.

In the evening the Engineers' Club of Baltimore tendered a reception and dance to the Society's members and guests in the ball room of the Hotel Belvedere.

Friday

Friday was spent at Annapolis. By high-speed interurban electric cars, the party was conveyed from Baltimore to Annapolis and upon arrival there was received by Governor Goldsborough in the senate chamber of the state capitol building. President Goss responded to the welcome of the Governor. Admiral H. I. Cone then addressed the gathering on the subject of the the Naval Experiment Station, stating something of the work it has done and is doing.

After a short walk around the town to see the places of historic interest the visitors assembled at Carvel Hall Hotel (originally the home of William Paca, one of the signers of the Declaration of Independence, where luncheon was served.

All of the afternoon was spent in the buildings and about the grounds of the Naval Academy. At the aviation camp, particularly interesting was it to see at close range the hydro-aeroplanes with which the naval officers have been having such great success. President Goss and a few other members of the society had the privilege of the experience of a short flight in the machines.

Also of special interest was the Naval Experiment Station in command of Capt. T. W. Kinkaid. Here a number of important investigations are just now in progress, including corrosion of metals, boiler compounds, lubricants, tests of sheet and rod packings, tests of valves, tests of gage glasses, tests of pressure regulators, feedwater and air heaters, evaporators and distillers, experimental steam turbines, forced-draft blowers, heat-transmission investigation, boiler tests with oil fuel, boiler tests with coal fuel, condensers and air pumps, centrifugal and rotary pumps, safety valves and calorimetry and specific heat.

Unfortunately rain interfered with some of the late afternoon program, for it had been planned to have a dress parade of the midshipmen with music by the Naval Academy band. The inclement weather sent most of the party back to Baltimore rather earlier than intended.

Altogether the meeting, while perhaps not one of the most remarkable the society has held in point of importance or great value of the papers presented or discussion drawn out, was nevertheless a very enjoyable one, and unusually well planned and conducted by the local engineers responsible for the entertainment.

*An account of the life of Captain Manning may be found in "Power," May 16, 1911, page 760

Annual Report of Topeka's Lighting Plant

SYNOPSIS—Operating costs of a small municipal plant carrying a lighting load. The system of records is unusually complete and includes all details of line and plant.

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As a basis for comparing the operating cost of a plant year in and year out there is nothing better than annual reports made up from the daily and monthly records of the plant. As an example which may be of general interest, we are reproducing in part the annual report on the municipal electric-lighting plant at Topeka, Kan. The report was issued by G. G. O'Neill, superintendent of the plant, and is unusually complete in all details.

In 1889 the city of Topeka purchased the lighting plant and in 1908 bonds to the amount of $65,000 were voted to rebuild the plant. Of this, $40,000 was used to install the Cooper-Hewitt constant-current mercury rectifier system with the Westinghouse metallic flame arc lamps. The value of the plant is at present approximately $65,000. The equipment is as follows: One Murray Corliss steam engine, 26x48 in.; one 260-kw. alternating-current Westinghouse, three-phase, 60-cycle generator; one 100-lamp, two-circuit Cooper-Hewitt rectifier set; three 75-lamp, one-circuit sets; five 50-lamp, one-circuit sets; one two-panel switchboard, instruments, etc.; three 18-ft. by 72-in. Bromich return-tubular boilers; one Sorge Cochrane open feed-water heater, and one 6x4x6-in. Advance hot-water feed pump.

On Dec. 31, 1912, the load consisted of 439 arc lamps, 70 series tungsten, and 785 one hundred-watt and 60-watt lamps for the White Way on Kansas Ave., West Ninth St. and East Fourth St. On Kansas Ave. each post of the White Way contains five 100-watt, upright lamps, totaling 400 cp. On the other streets of the White Way the posts have five upright lamps, the top being 100 watts, and the arm lamps 60 watts. Each post totals 292 candlepower.

The report gives in detail the operating conditions of the plant, conditions of the lines, cost per kilowatt-hour to generate current, cost per arc lamp, and White Way or special lighting costs, a comparison with other cities, also receipts and disbursements of the light department.

During the year 1911 a complete outfit of recording meters and instruments was installed in the plant, whereby the electrical output and working conditions could be ascertained. A set of scales was also installed for the weighing of coal. Beginning Jan. 1, 1912, a complete set of station charts was installed, consisting of a station log chart, engineers' supply chart, fuel record, chief lineman and trimmer chart, so that it was possible to keep a close record on the operating conditions. A set of books was also opened, consisting of a journal, ledger and trial balance. A summary of the data obtained is given in the accompanying table:

Operating fund	$16,293.26
Special lighting of White Way	3,077.09
Reconstruction fund	73.79
Total for year	$19,444.14

SPECIAL LIGHTING

Maintenance of Kansas Ave., White Way	$1,570.70
Maintenance of Fourth St., White Way (60 days)	178.07
Maintenance of Ninth St., White Way (83 days)	8.41
Installing special lighting	736.42
Cost to run feeders to and connect Fourth St.	395.99

SUMMARY OF ARC-LAMP DATA

Cost per arc lamp for year, all expenses added	$50.05
Adding 4½ per cent interest and 5 per cent depreciation	51.92
Actual cost per arc lamp for current and maintenance	19.53
Actual cost per arc lamp for labor, globes, electrodes	2.21
Actual cost per arc lamp for globes (only)	0.50
Actual cost per arc lamp for electrodes (only)	1.14
Actual cost per arc lamp for labor (only)	0.76

OUTPUT

Total output for the year 1912 in kilowatt-hours	503,260
Arc lamps consumed	380,890
White Way consumed	122,370

FUEL

Total coal consumed, tons	1,393.80
Total coal to generate steam, tons	1,267.89
Total coal to bank fires and for heating boilers, tons	125.91
Natural gas used as fuel, cu.ft.	11,183,632

WATER

Total amount during year, lb.	23,126,875
Total amount used in boilers, lb.	21,694,500

COST PER KILOWATT-HOUR

Coal, only	$0.00726
Natural gas	0.00857
Labor and engine supplies	0.01043
Coal, labor and engine supplies	0.01769

SUMMARY STATION CHARTS

Coal per kilowatt-hour, lb.	6.6
Water per kilowatt-hour, lb.	43.1
Water evaporated per pound of coal, lb.	6.5
Natural gas per kilowatt-hour, cu.ft.	85.73
Natural gas equivalent to 1 lb. coal, cu.ft.	13
Number hours arc lamps were off	1066
Hours plant was shut down	738.5
Hours machinery was in operation	3113
Hours arc lamps burned	2733
Arm lights on Kan. Ave., White Way burned, hr.	1768
Top lights on Kan. Ave., White Way burned, hr.	3113

In the White Way data it was shown that the operating and maintenance cost per pole for the year was $14.54, or $2.90 per lamp, which may be compared to $63 for the same size of lamp and a system exactly similar at Virginia, Minn., to $21 at Fort Wayne, Ind., for poles carrying 240 watts less, and to $50.02, which was the Edison company's charge per pole to furnish current and maintain the service.

As a matter of interest, it was stated that in treating the feed water to reduce scale in the boiler, the plant had been using a boiler compound that cost practically 7.2c. per thousand gallons of water treated. On Nov. 6 a change was made to graphite, at a cost of nine mills per thousand gallons treated. This amounted to a saving of $160 per year, with better results.

The employees were one superintendent, two engineers, three firemen, one lamp trimmer and one chief lineman, making a total of eight. The operating expenses for the plant for the year were as follows:

Miscellaneous expense	$1,404.81
Engine supplies	1,098.33
Series tungsten lamps	96.46
Line material	368.13
Extra labor	689.75
Salaries	6,787.65
Fuel, coal and natural gas	3,804.95
Maintenance of horse and wagon	117.78
Freight and drayage	159.73
Electrodes	485.00
Arc globes	152.75
Insurance	74.35
Mercury bulbs	1,053.59
Total	$16,293.26
Balance	106.74
Operating budget for year	$16,400.00

Other data showing the disbursements for the special lighting, reconstruction, arc-lamp data, giving the number of electrodes and globes used and the hours to trim, were given, also some recommendations for improvement, but, due to lack of space, these data must be omitted. Monthly figures on the load, coal, gas and water were also made up in tabular form from the station log charts, but as the totals for the year have been already given these tables have also been omitted.

Test of a Lentz Engine

Below is given results of a test on a 12x18-in. Lentz poppet-valve engine at Alliance, Neb. This engine is direct connected to a 100-kv.-a. Fort Wayne 2300-volt, 60-cycle, three-phase alternator, and with a 250-kv.-a. unit is installed in the municipal lighting plant. The contractor guaranteed this unit to deliver a kilowatt-hour at the switchboard with not more than 36 lb. of dry steam of 140 lb. pressure; exhaust to be free to the atmosphere and the unit to be fully loaded with a power factor of unity.

In conducting the test it was decided that it would be of more advantage to have the conditions the same as would occur in everyday operation, and by corrective factors check the results with the guarantee.

The water was first metered and then weighed on a tested scale. The boilers were fed by injectors with the overflow draining back to the water tank into which the feed water was dumped after being weighed. All boiler openings were blanked, save the main steam line, the drips of which were run to the water tank. Readings were taken every ten minutes, the load being held practically constant by water rheostats, which formed part of the load.

DATA OF TEST

Location	Alliance, Neb.
Date (six months after installation)	June 29, 1912
Duration of test	10:30 a.m. to 3:30 p.m.
Engine size, in.	12 × 18
Generator rating, kv.-a	100
Generator output, kw.-hr	446.5
Ammeter reading	256.6
Voltmeter reading	114.1
Apparent output, kv.-a	101
Power factor, per cent	88
Exciter output, kw.-hr	40
Total output, kw.-hr	486.5
Steam pressure, lb. gage	149.6
Back pressure, lb. gage	5
Per cent. moisture	1.5
Mean effective pressure	67.5
Indicated horsepower	156
Generator load factor, per cent	89
Total water, lb.	19,520
Water per hour, lb.	3,904
Kilowatts per hour of generator	89.3
Kilowatts per hour, including exciter	97.3
Steam per kw.-hr.	40.1
Steam per i.hp.-hr.	25
Correction for moisture, per cent	—1.5
Correction for 5-lb. back pressure, per cent	—11.0
Correction for steam pressure of 150 lb. instead of 140 lb., per cent	+1.5
Correction for power factor, per cent	—2.2
Steam per kw.-hr. with steam pressure of 140 lb., zero back pressure and 100 per cent. power factor, lb.	34.9
Steam per i.hp.-hr. under above conditions, lb.	22.25

This test was run by the light and water commissioner, who is a technical man with several years of experience. He had for his assistants the chief engineer of the plant, a representative of the engine builders and two seniors from the engineering department of the University of Nebraska. All instruments and scales were tested and it may be assumed with safety that the results are accurate.

International Engineering Congress

A committee on management of the International Engineering Congress, which will be held in connection with the Panama-Pacific International Exposition at San Francisco in 1915, has been appointed, consisting of the presidents and secretaries of the five national engineering societies under the auspices of which the congress is to be conducted, together with 18 members resident in San Francisco.

The committee has selected as its chairman Prof. W. F. Durand, of the American Society of Mechanical Engineers, and as its secretary-treasurer W. A. Cattell, of the American Society of Civil Engineers. The executive offices will be in the Foxcroft Building, 68 Post St., San Francisco.

Chairman Durand has selected members for the papers, finance, publicity and local affairs committees as follows: Papers committee, A. M. Hunt, American Institute of Electrical Engineers, chairman; finance committee, W. G. Dodd, Society of Naval Architects and Marine Engineers, chairman; publicity committee, W. A. Cattell, chairman, and local affairs committee, E. A. Benjamin, American Institute of Mining Engineers, chairman.

Engineers Wanted by N. Y. Civil Service Commission

Open competitive examinations will be held by the New York State Civil Service Commission for these positions:

Assistant Steam Engineer, Monroe County Service. Open to legal residents of Monroe County only. Candidates must have had two years' experience as machinist, boilermaker, steam fitter, oiler, fireman or engineer. Subjects of examination and relative weights: Practical questions on the operation and repair of steam boilers and pumps, 4; experience, education and personal qualifications, 6. Two vacancies exist at the Iola Sanatorium, West Brighton, at $75 per month or $60 per month with maintenance.

Junior Railway Engineer, Public Service Commission, First District. Salary $901 to $1200 per annum. The duties are to inspect the power houses and equipment of subway, elevated and street railways, and of electric companies in New York City. Candidates must have had at least three years' training in a technical school of recognized standing and not less than one year's experience in electric railroad or electric lighting work or in the manufacturing or installation of electrical or mechanical apparatus. Subjects of examination and relative weights: Theoretical and practical questions relating to the construction and operation of power-house and railway equipment, measurements, standards and other pertinent subjects, 5; experience and personal qualifications, 3; education, 2. Open to non-residents as above. No sample questions.

All applications must be in the commission's hands on or before June 6. Blanks may be had at the several cities offices ot the commission.

Trebling Its Plant Capacity

Plans have been prepared by the Pittsburgh Rys. Co., Pittsburgh, Penn., for trebling the capacity of its plant on Brunots Island, increasing the capacity from 25,000 kw. to 85,000. Twenty Stirling boilers of 822 hp. each have been ordered. The Westinghouse Co. will supply four 15,000-kw. turbo-generator sets. The condensers and pumps will be furnished by the Worthington Pump Company.

The boilers are to be placed in four batteries of five boilers each. A 14x180-ft. stack will be furnished for each battery.

I. E. S. Preparing for Annual Convention

At a meeting of the convention committee of the Illuminating Engineering Society, held in Pittsburgh, May 16, it was decided to hold the next annual convention in that city during the week beginning Sept. 22.

The committee consists of G. A. Littlefield, New York Edison Co., Chairman; P. S. Millar, Electrical Testing Laboratories, president; H. S. Evans, Macbeth Evans Glass Co.; W. A. Donkin, Duquesne Light Co., Pittsburgh; W. D. Macfarlan Moore, General Electric Co., Harrison, N. J.; M. C. Rypinski, Westinghouse Electric & Manufacturing Co., New York; C. J. Mundo, General Electric Co., Pittsburgh; J. C. McQuiston, Westinghouse Electric & Manufacturing Co., Pittsburgh; W. J. Serrill, United Gas Improvement Co., Philadelphia; S. B. Stewart, Philadelphia, Co., Pittsburgh, T. J. Pace, Westinghouse Electric & Manufacturing Co., Pittsburgh; and Prof. H. S. Hower, Carnegie Technical Schools, chairman of the local section of the society.

W. A. Donkin was selected as chairman of the local committee on arrangements and J. C. McQuiston was appointed chairman of the publicity committee.

It is expected that several hundred engineers from all parts of the country interested in lighting will be present. The program, the details of which have not been completed, will consist, in addition to the technical sessions, of a reception and dance, several excursion trips and visits to various industries in Pittsburgh.

New Jersey's N. A. S. E. Convention

Despite the continuous rain for the first two days of the New Jersey State convention of the National Association of Stationary Engineers, held in Palace Hall, Newark, Thursday, May 22 to Sunday the twenty-fifth, the exhibit and convention were most successful. Palace Hall is ideal for exhibits. Frank Martin, who has seen more halls and auditoriums than most of us, said it was the finest exhibit hall he had ever seen at any convention. Mayor Haussling opened the convention.

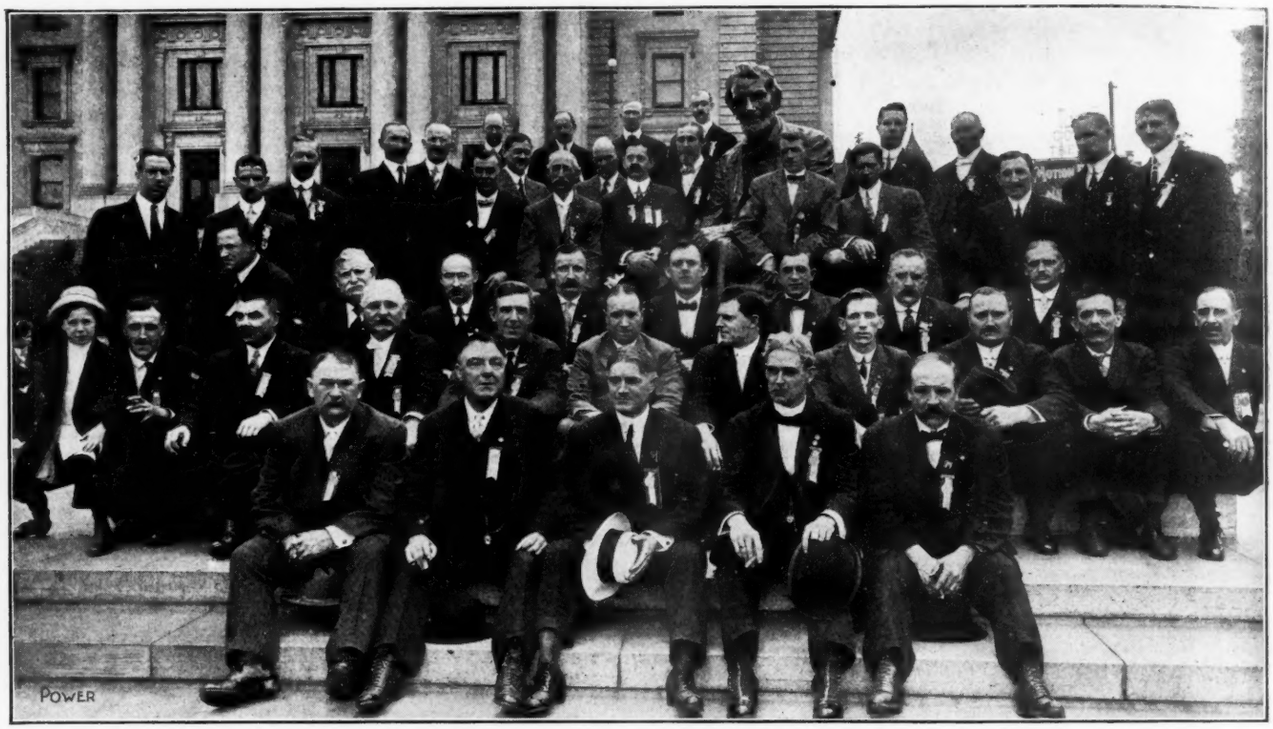
On Friday and Saturday afternoons meetings of the officers and delegates were held preparatory to the Sunday session in the meeting rooms of Newark No. 3 Association.

State President Martin J. Hickey, of Jersey City Association No. 1, called the convention to order at 11:25 a.m., and received the reports of the various committees. The report of A. L. Case, chairman of the license-law committee, was accompanied by a presentation to the president of the pen used by Governor Fieldler in signing the license law. This pen will be framed with the state charter.

The eulogy address on the deceased members was made by John J. Calahan, of Jersey City. Mrs. Parisan, state deputy of the Ladies Auxiliary, told of the achievements of that body.

Engineers of ten years' experience and who have been members of the N. A. S. E. for that length of time, are entitled to a pension should they become indigent. The present benefits amount to $15 per month, and it is hoped to increase this amount or reduce the time period for qualification.

National Vice-President James R. Coe reported that in 18 states there were 16 state associations, a total of 220 local associations representing 14,346 members.



SOME OF THE OFFICERS AND DELEGATES

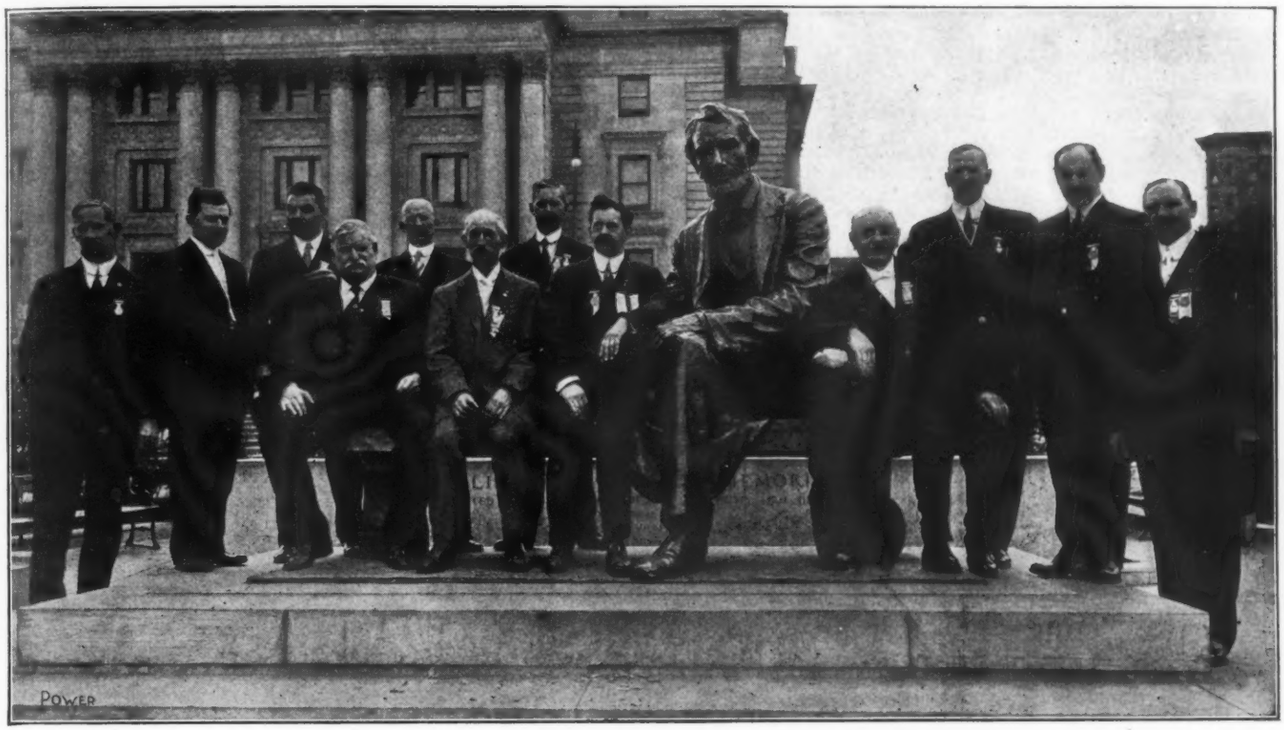
THOSE WHO ENJOYED THE BANQUET

The officers elected for the ensuing year are as follows: President, John T. Jenkinson, Paterson No. 2; vice-president, Charles W. Summers, Hoboken No. 1; treasurer, Thomas J. Brown, Newark No. 3, reëlected; secretary, John J. Ready, Jersey City No. 1; conductor, James S. Heath, Elizabeth No. 14; doorkeeper, Thomas McNamara, Paterson No. 2. The president was directed to recommend the retiring president, Martin J. Hickey, to the national officers for the office of state deputy. Past National President W. J. Reynolds installed the new officers.

The banquet in the Continental Hotel, Sunday evening, closed the convention. Toastmaster William J. Reynolds introduced the following speakers: J. H. Donnelly, president, Newark Common Council, whose speech was responded to by National Vice-President Coe. W. R. Sickle, counselor for the license-law committee, pointed out the necessity of getting the legislators now in special session to make the appropriation required to put the license law into immediate action.

C. H. Bromley, of Newark No. 3, and associate editor of "Power," told of the educational work in New Jersey. Stress was laid on the necessity for revising the slides and notes put out by the national educational committee in order to accomplish the best results in practical power-plant education.

F. R. Low, editor of "Power," reviewed the important feature of recent engineering progress, citing actual cases showing the necessity for greater qualifications of men to handle modern power plants. Past State President Martin Hickey told of the progress made in fraternal work during the past year.

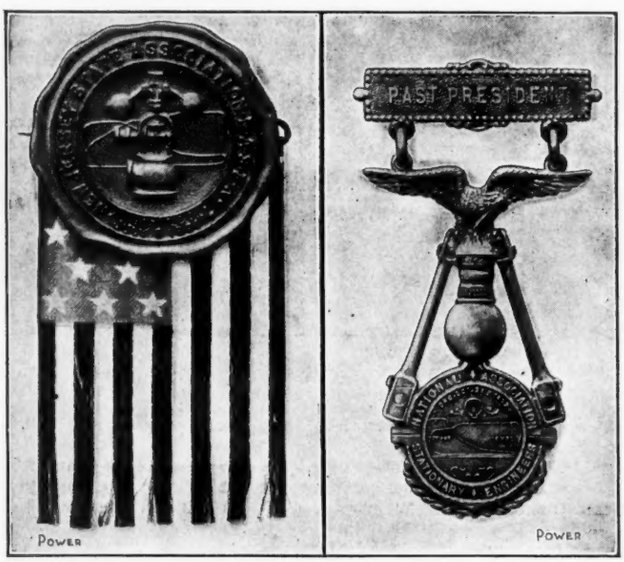


Past-Presidents N. J. State Association

Exhibit Hall, New Jersey N. A. S. E. Convention

Entertainment under the direction of Frank Martin was furnished by Herbert Self, Jim Devins, Billy Murray, Jack Armour, Joe McKenna and The Dixie Four, a female quartet of exceptional ability.

The exhibitors were the Albany Lubricating Co., Armstrong Cork Co., Ashton Valve Co., American Oil & Supply Co., Babcock & Wilcox Co., Boig & Hill, Buhne Metal Packing Co., Clipper Belt Lacer Co., Crandall Packing Co., Coppus Engineering & Equipment Co., Cooney Contracting Co., Clement Restien Co., Cinch Bolt Co., Crane & Milligan, C. T. Coe & Co., Crane Co., Couse & Bolton, C. E. Squires Co., Durabla Manufacturing Co., Dearborn Chemical Co., David C. Seymour, Diamond Power Specialty Co., Economy Fuse Manufacturing Co., F. W. Webb Manufacturing Co., Fairbanks Co., Greene, Tweed & Co., Garlock Packing Co., Griscom-Russell Co., Greenpoint Fire Brick Co., Harrison Safety Boiler Works, Home Rubber Co., H. W. Johns-Manville Co., Hill-McKanna Co., H. B. Underwood & Co., Hazard Manufacturing Co., Homestead Valve Manufacturing Co., Hewes & Phillips Iron Works, I. R. Nelson, Jenkins Bros., Jackson Awning Co., John A. Roebling Sons Co., J. H. Banks Co., Keystone Lubricating Co., Lunkenheimer Co., Ludlow & Squiers, Lagonda Manufacturing Co., Manning, Maxwell & Moore, M. T. Davidson Co., McLeod & Henry Co., Mutual Supply Co., New York Belting & Packing Co., "National Engineer," Norbin Oil & Supply Co., National Oil & Supply Co., Otis Elevator Co., "Practical Engineer,"



Peerless Rubber Manufacturing Co., Philadelphia Manufacturing Co., Pitts & Kitts Co., "Power," Precision Instrument Co., Philadelphia Grease Co., R. & J. Dick Co., Ross & Taggard, S. F. Bowser & Co., Strong, Carlisle & Hammond Co., Standard Oil Co., Standard Regulator Co., the A. & F. Brown Co., the United States Graphite Co., the Texas Co., V. D. Anderson Co., W. B. McVicker Co., William Powell Co., United Coal Savers' Association, United Metal Hose Co., Dick Belt Co., Quaker City Rubber Co., Chas. J. Hoffman, Engineers Blue Club of New Jersey, Ladies Auxiliary No. 2.

Pittsburgh's New Boiler Plant

The Crucible Steel Co. of America is building a model boiler plant at its works at Forty-first St. and the Allegheny Valley R.R., in the Lawrenceville district of Pittsburgh. The building alone will cost $95,000. It will cover a space of 252x45 ft. and will be 45 ft. high.

Fourteen 600-hp. boilers will be placed in the structure in seven batteries. Each battery will have a separate stack. By the use of smokeless stokers of the chain type the plant will be almost without smoke, thus enabling the company to comply with the laws of the city and state and add to the benefits to be conferred to the district.

SOCIETY NOTES

A party of British engineers arrived in New York on May 26. These visiting engineers are members of the institution of Automobile Engineers of England, and will attend the semiannual technical sessions of the Society of Automobile Engineers, under the auspices of which they will also make an inspection tour of automobile-manufacturing plants throughout the country.

The semiannual meeting of the Society of Automobile Engineers will be held on board a steamer cruising the Great Lakes. Four professional sessions will be held on June 5, 6 and 7, the party leaving Detroit on the "City of Detroit III," chartered exclusively by the society, on the afternoon of June 4. The technical discussion will be in part in connection with reports of the standards committee divisions on irons and steels, ball and roller bearings, motor-truck elements, starting, lighting and ignition systems, broaching tools, pneumatic-tire rims, fuel, motor testing and nomenclature. Several papers are to be presented by British engineers.

Elaborate arrangements for the edification and entertainment of the visiting European engineers have been made in New York, Pittsburgh, Indianapolis, Detroit, Cleveland, Buffalo, Providence, Bridgeport, New Haven and Hartford.

The summer meeting of the American Society of Heating and Ventilating Engineers will be held at Buffalo, N. Y., on July 17, 18 and 19. The headquarters will be at the Statler Hotel in that city.

The last meeting of the season of the Massachusetts Chapter of the American Society of Heating and Ventilating Engineers was held May 13, at Boston. The subject was humidity, and was discussed by W. C. Elliott, Stuart Cramer Co.; W. W. MacLean, Museum of Fine Arts; Charles F. Eveleth, School House Commission, Boston; Frank T. Chapman, of the New York Chapter. Mr. Elliott said that since the installation of the humidifying system in the Cheney Silk Mills there had been a wonderful freedom from all kinds of contageous diseases in the plant. Mr. MacLean explained that quite often they have loans of valuable furniture in the museum and such things would not be loaned to them unless they had special arrangements for placing the exhibit in an atmosphere where it would not fall to pieces. They also have on exhibition rare and costly paintings and Chinese lacquer work, which require uniform conditions. President Cooper read a communication which is of general interest. A commission has been appointed in New York by Governor Sulzer to make a special study of the heating and ventilating of school houses, which is made possible under a recent contribution of $50,000 by Mrs. Elizabeth Millbank Anderson. The committee to be appointed by Governor Sulzer will include Prof. C. E. A. Winslow, College of the City of New York; Prof. F. S. Lee, College of Physicians and Surgeons; James Alexander Miller, medical expert, Bellevue Hospital; Prof. E. B. Phelps, Massachusetts Institute of Technology; Prof. Edward L. Thorndike, Columbia University, and Dwight D. Kimball, engineer of New York City.

The subject of a midsummer meeting was taken up and an enjoyable outing is anticipated, which is left to the call of the president. The chapter meetings were adjourned until Oct. 14.

PERSONALS

N. T. Fortun has been elected manager of the Lyle (Minn.) electric-light plant, succeeding N. G. Fischer.

C. T. Wheat has succeeded William McKinley as superintendent of the Madison County Light & Power Co., Carlinville, Ill.

Charles Schaefer has succeeded W. H. Hartman as superintendent of the municipal electric-light and power plant at Opelika, Ala.

E. Cutting has been appointed superintendent of the municipal electric-lighting plant at Riverside, Calif., succeeding F. A. Worthley, resigned.

R. T. Morris, municipal electrician of South Vancouver, B. C., has resigned to associate himself with G. M. Gest, conduit engineer and contractor.

OBITUARY

JAMES WALKER

On May 8, James Walker, the founder and chairman of James Walker & Co., Ltd., "Lion" Works, London, England, died at his residence, Leytonstone. Mr. Walker had a wide acquaintance in the engineering field on both sides of the Atlantic, and was highly esteemed. He was 73 years old.

Mr. Walker's death will not occasion any change in the organization of which he was the head, as the management will be conducted, as heretofore, under the direction of George H. Cook, the managing director.